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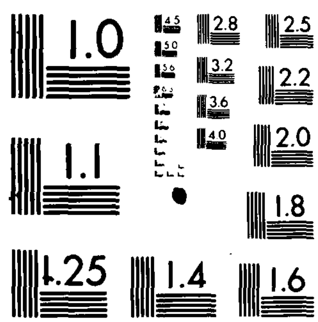

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26 February 1982

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The following is a major expansion of "Bibliography on Various Optical Testing Methods," by Daniel Malacara, Alejandro Cornejo, and M.V.R.K. Murty which appeared in Applied Optics, 14, 1065 - 1080 (1975). It is computerized to allow for easy update and correction. The last update was in September 1979. For availability information, please contact either of the authors. The present bibliography occupies 321 pages and includes the work of Cornejo et al. as an appendix.

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(ABOUT THE FINENESS, CORRECTION AND THE TESTING OF OPTICAL FLATS)
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"ZUR MESSUNG DER EBENHEIT VON REFLECKTIERENDEN FLACHEN MITTELS INTERFERENZEN GLEICHER DICKE"
(THE MEASUREMENT OF PLANES OF REFLECTING SURFACES USING FRINGES OF EQUAL THICKNESS)
Optik, 5, 354 (1949)

No abstract provided.

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"TESTING OF ASPHERICAL SURFACES WITH NEWTON FRINGES
Appl. Opt., 9,. 837 (1970)

The shape of any aspherical surface with rotational symmetry can be very easily found wih great accuracy using Newton fringes formed against a spherical test plate. To make it possible, a special mathematical procedure is devised for use with a special measuring system here described.

MECKEL, J.
"FRINGES, THEIR SENSITIVITY ACCORDING TO TEST CONFIGURATION"
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No abstract provided.

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Optical Shop Testing, Malacara, D., Ed.
CHAPTER 1. NEWTON, FIEZEAU, and HAIDINGER INTERFEROMETERS
John Wiley Publishing (1978)

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1.4 Absolute Testing of Flats

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"TESTING OF LARGE OPTICAL SURFACES WITH SMALL TEST PLATES"
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"ESTABLISHING AN OPTICAL FLATNESS STANDARD"
Appl. Opt., 10, 929 (1971)
Methods proposed by the authors to establish a flatness standard without using a liquid mirror are proved in practice and extended. The extension is performed by a development of methods for the determination and compensation of random and systematic measuring errors by means of condition equations which must be satisfied by the measured sums of deviations from absolute planeness. Linear errors of these sums of deviations which can lead to ambiguities and errors of planeness deviations can be discovered and completely eliminated. Also nonlinear errors, for example, as a result of temperature differences or of mechanical stress, can be recognized without repeating the interference photography procedure. The deviations from absolute planess of three fused silica plates were determined along seven diameters (angular distance 2 pi/14) with an accuracy of lamda/500 (mean square error). This was perfomed by evaluating two sets of four different interference photographs, each with contour plane distances of lamda/50 (from fringe to fringe).

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Optical Shop Notebook, IX, 1 (1975)
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"HOW FLAT IS FLAT" III
Opt. Spectra, 12, 32 (1978)
Parts I and II considered by theory of interference fringes and the interpretation of Newton's rings as used to determine the precise contours of polished optical surfaces. Part III analyzes the errors (A) viewing the test glass at an oblique angle rather than normal to the surface: and (B) the simple fact that there is the surface being tested. The theory is applied to a 4-inch (10 cm) radius test plate (2 Refs.).
Descriptors: OPTICAL TESTING; OPTICAL GLASS; LENSES; SURFACE TOPOGRAPHY MEASUREMENT; LIGHT INTERFERENCE;
Identifiers: FLAT; INTERFERENCE FRINGES; NEWTON'S RINGS; ERRORS; TEST GLASS RADING; POLLISHED OPTICAL SURFACE CONTOURS

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App. Opt., 7, 331 (1968)
A Fizeau interferometer is described with which to test the flatness of optical surface up to 240-mm dia. A mercury mirror of suitable diameter is used as a flatness standard. A simple 240-mm dia. lens is sufficient. For easy testing of the surfaces of wedge-shaped glass plates without adjustment difficulties the illumination and photographic arrangement, mounted in the same frame, can be tipped on an axis, going through the test surface. The influence of the aberration of the simple lens is discussed. Experimental results of the measurement of an optical flat are presented.

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Aust. J. Appl. Sci., 1, 243 (1950),
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Opt. Eng., 14, 520 (1975)
The optical fabrication and testing of the optical components for two large optical telescopes is described. These systems are the 88-inch aperture telescope for the University of Hawaii, and the 85-inch telescope for the Universidad de La Plata. A brief historical account of events leading to the large optics facility is included.

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Sov. J. Opt. Technol., 36, 545 (1969)
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THE UNIVERSAL FIZEAU INTERFEROMETER
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Appl. Opt., 8, 1373 (1959)
A new photographic technique for mapping pairs of coated optical flats, applicable to surfaces matched to lamda/10 or better, is described. By slowly changing the separation between the flats during exposure, interferograms are produced in which surface error is represented almost linearly by photographic transmission, and the surface defects distribution is determined from a large number of samples of the transmission of an interferogram. An illustrative example is discussed in which the surface defects distribution of a pair of Fabry-Perot plates is found to be asymmetric.

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Sov. J. Opt. Technol., 35, 559 (1968)
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"FIZEAU INTERFEROMETER-FRINGE SHARPENING"
Appl. Opt., 9, 2063 (1970)
A vector representation of the formation of fringe profiles in a Fizeau (wedge) interferometer shows that, under certain conditions, off-axis illumination may lead to fringe sharpening. The incident angle is such that the beam is first reflected toward the apex of the wedge and, following a certain controllable number of reflections, is reflected away from the apex. A typical example is shown.

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"SUR PLUSIEURS APPAREILS D'OPTIQUE DESTINES A CONTROLER LES SURFACES PLANES: PARALLELES, PERPENDICULAIRES ET OBLIQUES"
(ABOUT SEVERAL KINDS OF OPTICAL APPARATUS, DESIGNED TO CONTROL FLAT SURFACES: PARALLEL, PERPENDICULAR, AND OBLIQUE.)
C.R. Acad. Sci., 94, 134 (1883)
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"A LARGE INTERFEROMETER FOR THE EXAMINATION OF AIRCRAFT CAMERA WINDOWS"
Opt. and Laser Technol., 9, 158 (1977)
Describes a modified Fizeau interferoscope which has been developed for testing aircraft camera windows measuring up to 50 cm in diameter. Relatively cheap components are used for the large collimating lens and reference flats, and a small holographic optical element corrects for the residual errors of form (2 Refs.).
Descriptors: OPTICAL TESTING; LIGHT INTERFEROMETRY; OPTICAL ELEMENTS; CAMERAS
Identifiers: LARGE INTERFEROMETER; AIRCRAFT CAMERA WINDOWS; MODIFIED FIZEAU INTERFEROSCOPE; LARGE COLLIMATING LENS; REFERENCE FLATS; SMALL HOLOGRAPHIC OPTICAL ELEMENT; AERIAL PHOTOGRAPHY

MECKEL, J.
"FRINGES, THEIR SENSITIVITY ACCORDING TO TEST CONFIGURATION"
Optical Shop Notebook, IX, 82, (1975)
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"APPLICATION OF WAX TO FINE GROUND SURFACES TO SIMULATE POLISH"
Appl. Opt., 8, 2150 (1969).
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"THE DETERMINATION OF THE ABSOLUTE CONTOURS OF OPTICAL FLATS"
Appl. Opt., 6, 1917 (1967)
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"INTERFEROMETRIC FRINGE ANALYSIS"
Optical Shop Notebook, IX, 69 (1975)

INTRODUCTION

Interferometric fringe data reduction has been done subjectively for years. The evaluation was done by eye so that the quality of optical components was established qualitatively. Large companies have utilized complex computers to get quantitative data, but these methods have been beyond the reach of the majority of optical shops. We show here that it is now possible to do this analysis with a minimum of optical equipment and a relatively inexpensive desk-top calculator.

The type of fringes we are concerned with are formed by an interferometer of the reference wavefront type (as opposed to the shearing interferometer), and they can be obtained from a wide variety of test configurations. These include the methods known as Fizeau, Twyman-Green, laser unequal path, scatterplate, and test plate, among others. In all of these configurations, a wavefront is generated which is assumed to be perfect. This reference beam and the beam which samples the test element are combined and interfere with one another to produce light and dark bands. A tilt is often introduced between the two beams in order to get fringes which are more or less straight. The title is mainly a convenience. With appropriate techniques, the patterns obtained without a tilt (bull's eye fringes) can also be analyzed, though it is somewhat more complex and time consuming. A photograph is generally taken of the fringe pattern in order to get a permanent record and to be able to study the fringes without the vibrations often associated with viewing them in real time.

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"MAPPING OF HIGH QUALITY OPTICAL FLATS WITHOUT REFLECTION COATING"
J. Opt. Soc. Am., 52, 471 (1962).
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ROESLER, F.L. and TRAUB, W.
"PRECISION MAPPING OF PAIRS OF UNCOATED OPTICAL FLATS"
Appl. Opt., 5, 463 (1966)
No abstract provided.

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"PRECISE MEASUREMENT OF PLANENESS"
Appl. Opt., 6, 1077 (1967)
No abstract provided.

SCHULZ, G.
"NON-CONTACT TESTING OF THE SPHERICITY OF LENSES
Feingeraetetechnik, 26, 488 (1977)
Languages: GERMAN
The interference-optical testing of the sphericity of lens surfaces is treated. This method is especially applicable in spherical Fizeau-interferometers and in Twyman-Green-Interferometers (18 Refs.).
Descriptors: LENSES; OPTICAL TESTING; LIGHT INTERFEROMETRY; CURVATURE MEASUREMENT
Identifiers: SPHERICITY; LENSES; NONCONTACT TESTING; INTERFEROMETER

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J. Sci. Instrum., 34, 399 (1957)
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Opt. Eng., 14, 264 (1975)
The two terms 'Fringes of Defocusing' and 'Fringes of Lateral Displacemnt' are used in the interferometric testing of lens aberrations. The definition of these terms can be related to the three-dimensional intensity distribution near the focus of a spherical wave (5 Refs.)
Descriptors: LIGHT INTERFEROMETRY; OPTICAL TESTING; LENSES; ABERRATIONS
Identifiers: FRINGES OF DEFOCUSING; FRINGES OF LATERAL DISPLACMENT; INTERFEROMETRIC TESTING; LENS ABERRATIONS

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Appl. Opt., 7, 923 (1968)
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Appl. Opt., 8, 2555 (1969)
No abstract provided.

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Appl. Opt., 10, 1982 (1971)
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No abstract provided.

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"HAIDINGER INTERFERENCE IN CURVED PLATES"
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No abstract provided.

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"PRECISION MAPPING OF PAIRS OF UNCOATED OPTICAL FLATS"
Appl. Opt., 5, 463 (1966)
No abstract provided.

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Z. Instrumentenkd, 59, 31 (1939).

2 TWYMAN - GREEN AND WILLIAMS INTERFEROMETERS

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Atti Fond. Giorgio Ronchi Contrib. Ist. Naz. Ottica, 16, 666 (1961)
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Opt. Spectra, 4, 22 (1970)
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"THE THREE-BEAM INTERFEROMETER"
J. Opt. Soc. Am., 41, 870 (1951)
No abstract provided.

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"INTERFEROMETRIC TESTING OF OPTICAL SYSTEMS AND COMPONENTS
A REVIEW"
Opt. Laser Technol., 4, 28 (1972).
No abstract provided.

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"A VERSATILE LASER INTERFEROMETER"
Appl. Opt., 9, 2180 (1970)
No abstract provided.

BUBIS, I.YA. and KUZNETSOV, A.I.
"SOME PROBLEMS IN THE BUILDING AND USE OF AN INTERFEROMETER WITH A DIFFUSING PLATE"
Sov. J. Opt. Technol., 42, 400 (1975)
Advantages of diffusing plate interferometers over unequal-arm e.g., Twyman interferometers are discussed and the use of the former for testing of large-size objective lenses is described. In particular a scheme is suggested for producing the diffusing plate by double exposure of a photographic plate according to a technique shown diagrammatically. High resolution photographic plates are recommended for this purpose (4 Refs.).
Descriptors: LIGHT INTERFEROMETERS; OPTICAL TESTING; LENSES; LIGHT DIFFUSION
Identifiers: DIFFUSING PLATE INTERFEROMETERS; DIFFUSING PLATE PRODUCTION; OBJECTIVE LENS TESTING; DESIGN PROBLEMS

BUIN, A.P., SEMENOVA, M.P. and KIRYUKHINA, L.A.
"INSPECTION OF THE SURFACE QUALITY OF LARGE SCALE OPTICAL COMPONENTS OF AN UNEQUAL ARM INTERFEROMETER"
Sov. J. Opt. Technol., 36, 720 (1969)
No abstract provided.

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"THE WILLIAMS INTERFEROMETER"
Monthly Not R. Soc., 100, 488 (1940)
No abstract provided.

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Modern Interferometers
Hilger and Watts, London, 1951, Chaps. 6 and 7
No abstract provided.

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Optical Holography
Academic Press, New York, 1971, p.146
No abstract provided.

CONNES, P.
"AUMENTATION DU PRODUIT LUMINOSITE X RESOLUTION DES INTERFEROMETRES PAR L'EMPLOIE D'UNE DIFFERENCE DE MARCHE INDEPENDENTE DE L'INCIDENCE"
Rev. Opt., 35, 37 (1956)

No abstract provided.

COOK, A.H.
Interference of Electromagnetic Waves
Clarendon Press, Oxford, 1971, Chaps. 2 and 4
No abstract provided.

DEVANY, A.S.
"ON USING A WILLIAMS INTERFEROMETER FOR MAKING A DIVIDER PLATE"
Appl. Opt., 4, 365 (1965)
No abstract provided.

DEVANY, A.S.
"SUPPLEMENT TO: SOME ASPECTS OF INTERFEROMETRIC TESTING AND OPTICAL FIGURING"
Appl. Opt., 9, 1219 (1970)
No abstract provided.

DUTTON, D., CORNEJO, A., and LATTA, M.
"A SEMIAUTOMATIC METHOD FOR INTERPRETING SHEARING INTERFEROGRAMS"
Appl. Opt., 7, 125 (1968)
We describe a system for testing mirrors and lenses which uses a lateral shearing interferometer and laser light source, and in which data are recorded and processed digitally to obtain a description of the test wavefront in terms of a polynomial function, from which the shape of the test mirror may be computed automatic testing procedure.

DYSON, J.
"UNIT MAGNIFICATION OPTICAL SYSTEM WITHOUT SEIDEL ABERRATIONS"
J. Opt. Soc. Am., 49, 713 (1959)
No abstract provided.

ERICKSON, K.E.
"OPTICS TESTING INTERFEROMETER"
Appl. Opt., 3, 712 (1971)
Several extensions to the Twyman-Green interferometer are present in the preferred enbodiment: (1) laser source, (2) collimating telescope, (3) lens in reference beam, (4) at the focal point of the lens a reference plane reflector with gradiant reflectivity film so it may be displaced to balance the beam intensities, and (5) a lens in the test beam to fill the aperture of the system under test. Little is said about the availability of diffraction limited lenses for use in the reference and test beams. Simple thin field lenses at the mirror 25 and at focus 31 might be useful.

FORSYTHE, G.E.
"GENERATION AND USE OF ORTHOGONAL POLYNOMIALS FOR DATA-FITTING ON A DIGITAL COMPUTER"
J. Soc. Indus. Appl. Math., 5, 74 (1957).
No abstract provided.

GORDON, S.K. and JACOBS, S.F.
"MODIFICATION OF INEXPENSIVE MULTIMODE LASERS TO PRODUCE A STABILIZED SINGLE FREQUENCY BEAM"
Appl. Opt., 13, 231 (1974).
No abstract provided.

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"TWO BEAM INTERFEROMETER USING A LASER"
J. Opt. Soc. Am., 57, 149 (1967)
No abstract provided.

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ASTM Technical Publication 666. American Socity for Testing and Materials, Philadelphia (1978).
No abstract provided.

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"FRINGE SYSTEMS IN UNCOMPENSATED INTERFEROMETERS"
Proc. Phys. Soc., 33, 40 (1920)
No abstract provided.

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"INTERFEROMETER FOR OPTICAL TESTING WITH COMPUTER-GENERATED HOLOGRAMS"
Appl. Opt., 16, 546 (1976)
No abstract provided.

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"DIE SICHTBARKEIT DER IONTERFERENZEN BEIM TWYMAN-INTERFEROMETER"
(THE VISIBILITY OF INTERFERENCE FRINGES IN TWYMAN INTERFEROMETER)
Optik (Stuttg.), 12, 5 (1955)
No abstract provided.

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"THE SEPARATION OF SYMMETRICAL AND ASYMMETRICAL WAVEFRONT ABERRATIONS IN THE TWYMAN INTERFEROMETER"
Proc. Phys. Soc., 77, 328 (1961).
No abstract provided.

HARPER, D.C. and PICKERING, R.D.
"THE USE OF POWER COMPENSATION IN THE TESTING OF OPTICAL COMPONENTS IN THE TWYMAN-GREEN INTERFEROMETER"
J. Opt. Soc. Am., 43, 813 (1953)
No abstract proivded.

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"ROSS MODIFICATION OF THE HILGER INTERFEROMETER FOR TESTING LARGE OPTICAL ELEMENTS"
Opt. Soc., 31, 91 (1929)
No abstract provided.

HOPKINS, R.E.
"RE-EVALUATION OF THE PROBLEM OF OPTICAL DESIGN"
J. Opt. Soc. Am., 52, 1218 (1962)
No abstract provided.

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OPTICAL PRODUCTION TECHNOLOGY
Adam Hilger
London, 1972, and Crane Russak, New York, 1972, Chap. 11.
No abstract provided.

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"A LASER UNEQUAL PATH INTERFEROMETER FOR THE OPTICAL SHOP"
Appl. Opt., 6, 1237 (1967)
No abstract provided.

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"THE INTERFEROMETER PATTERNS DUE TO THE PRIMARY ABBERRATIONS"
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"THE ANALYSIS OF AN ITNERFEROGRAM"
Trans Opt. Soc., 28, 1 (1926)
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KINGSLAKE, R.
"THE INTERFEROMETER PATTERNS DUE TO THE REPEATED PRIMARY ABERRATIONS"
Trans. Opt. Soc., 27, 94 (1925)

No abstract provided.

KOCHER, D.G.
"TWYMAN-GREEN INTERFEROMETER TO TEST LARGE APERTURE OPTICAL SYSTEMS"
Appl. Opts., 11, 1872 (1972)
No abstract provided.

LANGENBECK, P.
"MULTIPASS TWYMAN-GREEN INTERFEROMETER"
Appl. Opt., 6, 1425 (1967)
No abstract provided

LANGENBECK, P.
"OPTICAL WAVEFRONT MAPPING BY DUAL INTERFEROMETRY"
J. Opt. Soc. Am., 58, 499 (1968)
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MALACARA, D.
Optical Shop Testing, Malacra, D., Ed., 1978
CHAPTER 2. TWYMAN-GREEN INTERFEROMETER
2.1 Introduction
2.1.1. Beam-Splitter Plate
2.2 Coherence Requirements
2.2.1. Spatial Coherence
2.2.2. Temporal Coherence
2.3 Uses of a Twyman-Green Interferometer
2.3.1. Tesiting of Prisms and Diffraction Rulings
2.3.2. Testing of Lenses
2.3.3. Testing of Microscope Objectives
2.4 Unequal-Path Interferometer
2.4.1. Some Special Designs
2.5 Photoghraphy of the Interference pattern
2.6 Typical Interferograms and Their Analysis
2.6.1. Analysis of Interferograms of Arbitrary Wavefronts

MARECHAL, A. and DEJONC, P.
"QUELQUES ASPECTS DES FRANGES DE TWYMAN" (SOME ASPECTS OF TWYMAN FRINGES)
Rev. Opt. Theor. Instrum., 29, 430 (1950)
No abstract provided.

MARTIN, L.C. and KINGSLAKE, R.
"THE MEASUREMENT OF CHROMATIC ABERRATION ON THE HILGER LENS TESTING INTERFEROMETER"
Trans. Opt. Soc., 25, 213 (1923)
No abstract provided.

MASUDA, T., NISHIYAMA, S., NAKATA, T., and ADACHI, I.
"THE TESTING OF OPTICAL MATERIALS BY THE TWYMAN TYPE INTERFEROMETER II"
Atti Fond. Giorgio Rochi Contrib. Ist. Naz. Ottica, 17, 197 (1962)
No abstract provided.

MCDONOUGH, R.
"FRINGE PATTERNS IN INTERFEROMETERS"
Optical Shop Notebook, IX, 111 (1975)
Over the last several years the use of laser interferometry in the Twyman-Green arrangement has become much more convenient and versatile. The essential interferometer action is comparison of a flat reference wavefront with the wavefront from an optical system under test. The resultant fringe pattern always contains the same information about the test wavefront; sometimes the nature of the wavefront error can be identified by visual inspection. However, the appearance of the fringe pattern changes as relative tilt and power of the reference and test wavefronts are varied.

The orientation of unsymmetric errors with respect to tilt direction also changes the appearance of the fringe pattern. This is a presentation of the varying appearance of Twyman-Green fringe patterns due to some simple wavefront errors. It is intended to give the beginner in fringe pattern interpretation a look at idealized shapes which may help in the recognition of errors on real wavefronts.

MICHELSON, A.A.
"ON THE CORRECTION OF OPTICAL SURFACES"
Astrophys. J., 47, 283 (1918)
No abstract provided.

MOORE, D.T., MURRAY, R., and NEVES, F.B.
"LARGE APERTURE AC INTERFEROMETER FOR OPTICAL TESTING"
Appl. Opt., 17, 3959 (1978)
A 20 cm clear aperture modified Twyman-Green interferometer is described. The system measures phase with an AC technique called phase-lock interferometry while scanning the aperture with a dual galvanometer scanning system. Position information and phase are stored in a minicomputer with disk storage. This information is manipulated with associated software, and the wavefront deformation due to a test component is graphically displayed in perspective and contour on a CRT terminal.

MOORE, R.C.
"AUTOMATIC METHOD OF REAL-TIME WAVEFRONT ANALYSIS"
Opt. Eng., 18, 461 (1979)

A technique for real-time measurement of interferograms is described which circumvents the common sources of error in traditional methods of analysis. By nulling the interferometer and simultaneously measuring the phase over a rectilinear grid, error due to geometric distortion in the interferometer (which produces apparent coma terms in the analysis of straight line interferograms), uneven pupil illumination (which shifts the apparent location of the fringe peaks), and the difficulty in fitting and interpolation of polynomials to unevenly sampled pupil functions are eliminated. Data are not interpolated or artificially smoothed, so localized irregularities in the wavefront are visible in the results. Because on-line computer processing is used, contour and isometric plots are displayed less than two minutes after data taking is completed. A unique interface design permits utilization of virtually all of the information present in the input video signal. By taking thousands of measurements per minute at each point in the wavefront, and extending the measurement over several minutes, the effects of vibration and turbulence are averaged out of the data. With a reasonably stable interferometer, the effective instrument bandwidth can be reduced to 0.01 Hz providing worst point peak-to-peak repeatabilities of successive measurements of better than lamda/100. For repeatabilities of lamda/20, data taking times can be reduced below two seconds.

MOTTIER, F.M.
"MICROPROCESSOR-BASED AUTOMATIC HETERODYNE INTERFEROMETER"
Opt. Eng., 18, 464 (1979)

The interferometer described in this article combines a number of principles known for a long time in a system of unusual versatility. The operation modes range from classical interferometry for visual or photographic evaluation of apertures up to 150 mm diameter, to programmed scan heterodyne interferometry with fringe counting and to time- and spaced-resolved subfringe measurement with better than 10 nm resolution. The instrument is primarily intended as a diagnostic tool in adaptive optics to monitor the deformable corrector mirror during operation.

MOROKUMA, T., NEFLEN, K.F., LAWRENCE, T.R., and KLUCHER, T.M.
"INTERFERENCE FRINGES WITH LONG PATH DIFFERENCE USING HE-NE LASER"
J. Opt. Soc. Am., 53, 394 (1963)

No abstract provided.

MUNNERLYN, C.K., GIVENS, M.P., and HOPKINS, R.E.
"INTERFEROMETRIC MEASUREMENTS OF OPTICALLY ROUGH SURFACES"
IEEE J. Quantum Electron, QE-5, 359 (1969)

No abstract provided.

MUNNERLYN, C.R.
"DIFFRACTION GRATING INTERFEROMETER"
Appl. Opt., 11, 1883 (1971)

This is an unequal path Twyman-type interferometer for testing optical surface, particularly at wavelengths in the IR. The beam divider is a reflection diffraction grating. The plus one order diffracts, reflects off of the test mirror, and returns to the grating. The zero order of the return beam and the minus one order of the incident beam interfere.

MURTY, M.V.R.K.
"SIMULATION OF PRIMARY ABERRATIONS OF A LENS USING A GENERALIZED MICHELSON INTERFEROMETER"
J. Opt. Soc. Am., 50, 1089 (1960)
No abstract provided.

MURTY, M.V. R.K.
"INTERFERENCE BETWEEN WAVEFRONTS ROTATED OR REVERSED WITH RESPECT TO EACH OTHER AND ITS RELATION TO SPATIAL COHERENCE"
J. Opt. Soc. Am., 54, 1187 (1964)
No abstract provided.

OSTROVSKAYA, M.A. and FILIMONOVA, N.F.
"USE OF THE GASE LASER FOR INTERFEROMTRIC QUALITY CONTROL IN TELESCOPE MANUFACTURE"
Sov. J. Opt. Technol., 36, 563 (1969)
No abstract provided.

PASTOR, J. and LEE, P.H.
"TRANSMISSION FRINGES IN REFLECTION MULTIPLE BEAM INTERFEROMETRY"
J. Opt. Soc. Am., 58, 149 (1968)
No abstract provided.

PERRY, J.W.
"THE DETERMINATION OF ABERRATIONS, AS EXPRESSED IN GEOMETRICAL OPTICS, FROM THE INDICATIONS OF THE HILGER INTERFEROMETER"
Trans. Opt. Soc., 25, 97 (1923)
No abstract provided.

PETERS, W.N. and IVALDI, J.
"MOIRE PHASE-MEASURING INTERFEROMETER FOR ASPHERIC MIRRORS"
J. Opt. Soc. Am., 61, 655 (1971)
No abstract provided.

RANCOURT, J.D.
"INTERFEROMETRIC FRINGE ANALYSIS"
Optical Shop Notebook, IX, 69 (1975)
Interferometric fringe data reduction has been done subjectively for years. The evaluation was done by eye so that the quality of optical components was established

qualitatively. Large companies have utilized complex computers to get quantitative data, but these methods have been beyond the reach of the majority of optical shops. We show here that it is now possible to do this analysis with a minimum of optical equipment and a relatively inexpensive desk-top calculator.

The type of fringes we are concerned with are formed by an interferometer of the reference wavefront type (as opposed to the shearing interferometer), and they can be obtained from a wide variety of test configurations. These include the methods known as Fizeau, Twyman-Green, laser unequal path, scatterplate, and test plate, among others. In all of these configurations, a wavefront is generated which is assumed to be perfect. This reference beam and the beam which samples the test element are combined and interfere with one another to produce light and dark bands. A tilt is often introduced between the two beams in order to get fringes which are more or less straight. The title is mainly a convenience. With appropriate techniques, the patterns obtained without a tilt (bull's eye fringes) can also be analyzed, though it is somewhat more complex and time consuming. A photograph is generally taken of the fringe pattern in order to get a permanent record and to be able to study the fringes without the vibrations often associated with viewing them in real time.

RIMMER, M.P., KING, D.M., and FOX, D.G.
"COMPUTER PROGRAM FOR THE ANALYSIS OF INTERFEROMETRIC TEST DATA"
Appl. Opt., 11, 2790 (1972)
No abstract provided.

RIMMER, M.P. and WYANT, J.C.
"EVALUATION OF LARGE ABERRATIONS USING A LATERAL-SHEAR INTERFEROMETER HAVING VARIABLE SHEAR"
Appl. Opt., 14, 142 (1975)
A variable shear lateral shearing interferometer consisting of two holographically produced crossed diffraction gratings is used to test nonrotationally symmetric wavefronts having aberrations greater than 100 wavelengths and slope variations of more than 400 wavelengths/diameter. Comparisons are made with results of Twyman-Green interferometric tests for wavefront aberrations of up to thirty wavelengths. The results indicate that small wavefront aberrations can be measured as accurately with the lateral-shear interferometer as with the Twyman-Green interferometer and that aberration that cannot be measured at all with a Twyman-Green interferometer can be measured to about 1% accuracy or better.

ROGERS, G.L.
"THE EQUIVALENT INTERFEROMETER IN HOLOGRAPHY"
Opt. Acta, 17, 527 (1970)
No abstract provided.

SAUNDERS, J.B.
"PRECISION METHOD FOR EVALUATING PRIMARY ABERRATIONS OF LENSES WITH A TWYMAN INTERFEROMETER"
J. Res. Nat. Bur. Stand., 69C, 251 (1965)
No abstract provided.

SCHULZ, G.
"NON-CONTACT TESTING OF THE SPHERICITY OF LENSES"
Feingeraetetechnik, 26, 488 (1977)
Languages: GERMAN
The interference-optical testing of the sphericity of lens surfaces is treated. This method is especially applicable in spherical Fizeau-interferometers and in Twyman-Green-Interferometers (18 Refs.).
Descriptors: LENSES; OPTICAL TESTING; LIGHT INTERFEROOMETRY; CURVATURE MEASUREMENT
Identifiers: SPHERICITY; LENSES; NONCONTACT TESTING; INTERFEROMETER

SLEVOGT, H.
"ZUR GEOMETRISCHEN OPTIK DER ZWEISTRAHL-INTERFEROMETER" (ABOUT THE GEOMETRICAL OPTICS OF TWO-BEAM INTERFEROMETERS)
Optik, 11, 366 (1954)
No abstract provided.

SHACK, R.
"TESTING"
Optical Shop Notebook, IX, 1 (1975)
No abstract provided.

SMITH, T.
"THE THEORY OF THE LENS-TESTING INTERFEROMETER"
Trans. Opt. Soc., 28, 104 (1926)
No abstract provided.

STEEL, W.H.
"ADJUSTABLE COMPENSATORS FOR TWO-BEAM INTERFEROMETERS"
Opt. Acta, 9, 111 (1962)
No abstract provided.

STEEL, W.H.
"THE COMPENSATION OF A WILLIAMS INTERFEROMETER"
Opt. Acta, 10, 206 (1963)
No abstract provided.

STEEL, W.H.
"TWO-BEAM INTERFEROMETRY"
Progress in Optics, Vol. 5, E. Wolf, Ed., North-Holland, Amsterdam, 1966, Chap. 3
No abstract provided.

"DETERMINATION OF THE DIHEDRAL ANGLE ERRORS OF A CORNER CUBE FROM ITS TWYMAN-GREEN INTERFEROGRAM"
J. Opt. Soc. Am., 67, 467 (1977)
No abstract provided.

TWYMAN, F. and GREEN, A.
British Patent 102832 (1916)

TWYMAN, F.
"CORRECTION OF OPTICAL SURFACES"
Astrophys. J., 48, 256 (1918)
No abstract provided.

TWYMAN, F.
"INTERFEROMETERS FOR THBE EXPERIMENTAL STUDY OF OPTICAL SYSTEMS FROM THE POINT OF VIEW OF THE WAVE THEORY"
Philos. Mag. Ser. 6, 35, 49 (1918)
No abstract provided.

TWYMAN, F.
"AN INTERFEROMETER FOR TESTING CAMERA LENSES"
Trans. Opt. Soc., 22, 174 (1920)
No abstract provided.

TWYMAN, F.
"THE TESTING OF MICROSCOPE OBJECTIVE AND MICROSCOPES BY INTERFEROMETRY"
Trans. Faraday Soc., 16, 208 (1920)
No abstract provided.

TWYMAN, F.
"THE HILGER MICROSCOPE INTERFEROMETER"
Trans. Opt. Soc., 24, 189 (1922)
No abstract provided.

TWYMAN, F.
"THE INTERFEROMETER IN LENS AND PRISM MANUFACTURE"
Nature, 151, 43 (1943)
No abstract provided.

TWYMAN, F. and DALLADAY, A.J.
"VARATION IN REFRACTIVE INDEX NEAR THE SURFACES OF GLASS MELTS"
Trans. Opt. Soc., 23, 131 (1921)
No abstract provided.

TYNES, A.R. and BISBEE, D.L.
"PRECISE INTERFEROMETRY OF GLASS PLATES"
IEEE J. Quantum Electron, QE-3, 459 (1967)
No abstract provided.

VAN HEEL, A.C.S. and SIMONS, C.A.J.
"LENS AND SURFACE TESTING WITH COMPACT INTERFEROMETERS"
Appl. Opt., 6, 803 (1967)
Easily manufacturable components are assembled into compact modified Twyman-Green interferometers and an interference microscope with only one objective.

WATRASIEWICZ, B.M.
"TURNED EDGE FRINGES IN THE TWYMAN-GREEN INTERFEROMETER DUE TO FOCUSING ERRORS"
J. Sci. Instrum., 42, 897 (1965)
No abstract provided.

WEINSTEIN, W.
"A BEAM SPLITTER FOR NON-COLLIMATED LIGHT"
J. Sci. Instrum., 28, 351 (1951)
No abstract provided.

YOUNG, T.R.
"TEST OF AERIAL CAMERA LENSES OF LARGE APERTURE WITH A TWYMAN INTERFEROMETER"
J. Opt. Soc. Am., 42, 874 (1952)
No abstract provided.

3 COMMON PATH INTERFEROMETER

3.1 BURCH INTERFEROMETER

BURCH, J.M.
"SCATTER FRINGES OF EQUAL THICKNESS"
Nature, 171, 889 (1953)
No abstract provided.

AUGUSTYN, W.H. JR
"COMMON PATH INTERFEROMETRY"
Opt. Eng., 12, 180 (1973)
Two types of common path interferometers used for testing both components and complete lens system are discussed. A new form of the common path interferometer is described in detail and it can be seen that this form compliments the more familiar scatterplate type interferometer. This new design has been packaged for mobility and ease in handling in the optical shop.
Descriptors: LIGHT INTERFEROMETERS; OPTICAL TESTING; LENSES
Identifiers: COMON PATH INTERFEROMETERS; LENS SYSTEMS; SCATTERPLATE TYPE INTERFEROMETER

BURCH, J.M.
"SCATTER-FRINGE INTERFEROMETRY"
J. Opt. Soc. Am., 52, 600 (1962)
No abstract provided.

DE WITTE, A.J.
"INTERFERENCE IN SCATTERED LIGHT"
Am. J. Phys., 35, 301 (1967)
No abstract provided.

HOUSTON, J.B. JR
"HOW TO MAKE AND USE A SCATTERPLATE INTERFEROMETER"
Opt. Spectra, 4, 32 (1970)
No abstract provided.

MALLICK, S.
CHAPTER 3. COMMON-PATH INTERFEROMETERS
Optical Shop Testing, Malacara, D., Ed. (1978)

MCKAUGHLIN, J.L.
"PRACTICAL INTERFEROMETRY AT 1.06 MICRONS"
Soc. Photo-Optical Instrumentation Engineers, (1977)

A laser unequal path interferometer (LUPI) was constructed for testing of lenses at 1.06 microns. The author presents the design tradeoff consideration in choosing an unequal path versus an equal path interferometer. Thermal perturbations and the solutions are discussed and component descriptions are presented. The means of viewing the resultant interferograms and recording them on film are also described.

Descriptors: LIGHT INTERFEROMETERS; OPTICAL TESTING; LENSES
Identifiers: TESTING of LENSES; 1.06 MICRONS; DESIGN TRADEOFF CONSIDERATIONS; COMPONENT DESCRIPTIONS; THERMAL PERTURBATIONS

PUNTAMBEKAR, P.N. and SEN, D.
"A SIMPLE INVERTING INTERFEROMETER"
Opt. Acta, 18, 719 (1971)

A simple, common path inverting interferometer is described. The interference pattern shows the anti-symmetical wavefront error about the axis of inversion and the path difference is always zero at the centre of the pattern. It is shown that, in this interferometer, collimation errors have negligible effect. The interferometer is suitable for testing concave mirrors and convex lenses (15 Refs.).

Descriptors: INTERFEROMETERS LIGHT; OPTICAL INSTRUMENT TESTING; LENSES; MIRRORS

Identifiers: COMMON PATH INVERTING INTERFEROMETER; INTERFERENCE PATTERN; AXIS OF INVERSION; PATH DIFFERENCE; COLLIMATION ERRORS; TESTING; CONCAVE MIRRORS; CONVEX LENSES; ANTI SYMMETRICAL WAVEFRONT ERROR

SCHOEMAKER, A.H. and MURTY, M.V.R.K.
"SOME FURTHER ASPECTS OF SCATTER FRINGE INTERFEROMETRY"
Appl. Opt., 5, 603 (1966)

No abstract provided.

SCOTT, R.M.
"SCATTER PLATE INTERFEROMETRY"
Appl. Opt., 8, 531 (1969)

No abstract provided.

3.2 FRESNEL ZONE PLATE INTERERONETER

CHAMPAGNE, E.
"OPTICAL METHOD FOR PRODUCING FRESNEL ZONE PLATES"
Appl. Opt., 7, 381 (1968)

No abstract provided.

CHAU, H.M.
"ZONE PLATES PRODUCED OPTICALLY"
Appl. Opt., 8, 1209 (1969)

No abstract provided.

DYSON, J.
"INTERFEROMETERS"
Concepts of Classical Optics, Append. B. 377 (1975)
San Francisco, 1957b, Appendix B p. 377
No abstract provided.

MILES, C.L.
"THE PRODUCTION OF FRESNEL AND SINE WAVE ZONE PLATES"
Appl. Opt., 7, 976 (1968)
No abstract provided.

MURTY, M.V.R.K.
"COMMON PATH INTERFEROMETER USING FRESNEL ZONE PLATES"
J. Opt. Soc. Am., 53, 568 (1963)
No abstract provided.

3.3 BIREFRINGENT AND POLARIZATION INTERFEROMETERS

DYSON, J.
"A COMMON-PATH INTERFEROMETER FOR TESTING PURPOSES"
J. Opt. Soc. Am., 47, 386 (1957)
No abstract provided.

DYSON, J.
"VERY STABLE COMMON-PATH INTERFEROMETERS AND APPLICATIONS"
J. Opt. Soc. Am., 53, 690 (1963)
No abstract provided.

FRANCON, M. and JORDERY, M.
"APPLICATION DES INTERFERENCES PAR DOUBLE REFRACTION
A L'ETUDE DES ABERATIONS"
Rev. Opt., 32, 601 (1953)
No abstract provided.

FRANCOM, M. and MALLICK, S.
"POLARIZATION INTERFEROMETERS"
John Wiley, New York (1971)
No abstract provided.

MALLICK, S.
"MEASUREMENT OF OPITCAL TRANSFER FUNCTION WITH POLARIZATION INTERFEROMETER"
Opt. Acta, 13, 247 (1966)
No abstract provided.

MURATA, K.
"INSTRUMENTS FOR THE MEASURING OF OPTICAL TRANSFER FUNCTIONS"
Progress in Optics, Vol. 5
Wolf, Ed., North-Holland, Amsterdam, 201 (1966)
No abstract provided.

STEEL, W.H.
"A POLARIZATION INTERFEROMETER FOR THE MEASUREMENT OF TRANSFER FUNCTIONS"
Opt. Acta, 11, 9 (1964)
No abstract provided.

TSURUTA, T.
"MEASUREMENT OF TRANSFER FUNCTIONS OF PHOTOGRAPHIC OBJECTIVES BY MEANS OF A POLARIZING SHEARING INTERFEROMETER"
J. Opt. Soc. Am., 53, 1156 (1963)
No abstract provided.

3.4 KOSTER'S PRISM INTERFEROMETER

NAESS, R.O.
"A MEASURING INTERFEROMETER FOR HIGH ACCURACY ALIGNMENT"
An interferometer is described that is capable of measuring the deviation of a target device from a plane with an accuracy of 0.1 mu, when the interferometer-target separation is as much as 10 m. This interferometer resembles one described in 1965 by Baldwin and Whitten in that they both use a Kosters prism and a Porro prism. The present use of a laser for the light source yields nonlocalized fringes at the output that are easily monitored by an electronic fringe detector.

PHILBERT, M.
"APPLICATIONS METROLOGIQUES DE LA STRIOSCOPIE INTERFERENTIELLES"
Rev. Opt., 37, 598 (1958)
No abstract provided.

PHILBERT, M. and GARYSON, M.
"REALISATION ET CONTROLE PAR STRIOSCOPIE INTERFERENTIELLE DE MIROIRS PLANS, SPHERIQUES ET PARABOLIQUES"
Optical Instruments and Techniques,
Habell, K.J., Ed., Chapman and Hall, London, 352 (1961)
No abstract provided.

PRAT, R.
"SPECTROMETRIE DES FREQUENCES SPATIALES ET COHERENCE"
Opt. Acta, 13, 73 (1966)
No abstract provided.

SAUNDERS, J.B.
"CONSTRUCTION OF A KOSTER'S DOUBLE-IMAGE PRISM"
J. Res. Nat. Bur. Stand., 58, 21 (1957)
No abstract provided.

SAUNDERS, J.B.
"THE KOSTERS DOUBLE-IMAGE PRISM"
Concepts of Classical Optics
Strong, J., W.H. Freeman, San Francisco, Appendix C, 393 (1957)
No abstract provided.

SAUNDER, J.B. and GROSS, F.L.
"INTERFEROMETER FOR LARGE SURFACES"
J. Res. Nat. Bur. Stand., 62C, 137 (1959)
No abstract provided.

SAUNDERS, J.B.
"A NEW METHOD OF MEASURING GAUGE BLOCKS"
J. Res. Nat. Bur. Stand., 64C, 173 (1960)
No abstract provided.

SAUNDERS, J.B.
"LARGE APERTURE INTERFEROMETERS WITH SMALL BEAM DIVIDERS"
J. Res. Nat. Bur. Stand., 67C, 201 (1963)
No abstract provided.

SAUNDERS, J.B.
"AN ALIGNMENT INTERFEROMETER"
Appl. Opt., 2, 541 (1963)
No abstract provided.

SAUNDERS, J.B.
"AN ALIGNMENT INTERFEROMETER"
J. Res. Nat. Bur. Stand., 67C, 307 (1963)
No abstract provided.

SAUNDERS, J.B.
"AN INTERFEROMETER FOR MEASURING GRADIENTS IN BOTH REFRACTIVE INDEX AND THICKNESS OF LARGE OR SMALL OPTICS"
J. Res. Nat. Bur. Stand., 73C, 1 (1969)
No abstract provided.

SMARTT, R.N. and STRONG, J.
"POINT-DIFFRACTION INTERFEROMETER"
J. Opt. Soc. Am., 62, 737 (1972)
No abstract provided.

SMARTT, R.N. and STEEL, W.H.
"THEORY AND APPLICATION TO POINT-DIFFRACTION INTERFEROMETERS"
Proceedings of the ICO Conference on Optical Methods in Scientific and Industrial Measurements, Tokyo, 1974
Jap. J. Appl. Phys., 14, Suppl. 1, 351 (1975)
No abstract provided.

TEW, E.J.JR.
"MEASUREMENT TECHNIQUES USED IN THE OPTICS WORKSHOP"
Appl. Opt., 5, 695 (1966)
Measurement techniques used in the optics workshop often are complex and demanding. Characteristics considered are flatness, parallelism, angularity, curvature, length, and surface quality. Types of measuring equipment common to the workshop and their relative accuracies are discussed. The present usage of the Kosters prism as a workshop measuring devise is also discussed.

4 LATERAL SHEARING INTERFEROMETER

4.1 GENERAL

ARECCHI, F.T., BASSAN, M., JACOBS, S.F., and MOLESINI, G.
"MTF MEASUREMENT VIA DIFFRACTION SHEARING WITH OPTICALLY SUPERIMPOSED GRATINGS"

The use of double diffraction shearing for measurement of MTF is demonstrated. By superimposing two gratings optically the authors avoid the problem of grating contact and subsequent degradation. This simple and economical method is especially advantageous for optical systems with large pupil for which a rotating plate interferometer becomes prohibitively expensive (11 Refs).

Descriptors: OPTICAL TESTING; LENSES; DIFFRACTION GRATINGS; LIGHT INTERFEROMETERS; OPTICAL TRANSFER FUNCTION

Identifiers: MTF MEASUREMENT; DIFFRACTION SHEARING; OPTICALLY SUPERIMPOSED GRATINGS; LARGE PUPIL OPTICAL SYSTEMS; LENS TESTING; DOUBLE GRATING INTERFEROMETER

ASHTON, A. and MARCHANT, A.C.
"A SCANNING INTERFEROMETER FOR WAVEFRONT ABERRATION MEASUREMENTS"
App. Opt., 8, 1953 (1969)

The fundamental principles of operation and of the design of a new type of lateral shearing interferometer are described. This instrument has the advantage over existing devices that no computation is required in order to derive the wavefront shape from the interferogram. Instead, the aberration is obtained directly by measurement of the variation of phase difference at the center of one of the component wavefronts as it is scanned across the other. The technique lends itself readily to automatic recording of wavefront aberrations.

BATES, W.J.
"A WAVEFRONT SHEARING INTERFEROMETER"
Proc. Phys. Soc. Lond., 59, 940 (1947)

No abstract provided.

BIRCH, K.G. and GREEN, F.J.
"INTERFEROMETRIC TESTING OF ASPHERIC SURFACES"
Nat. Phys. Lab., 18, 11 (1972)

Discusses lateral shearing interferometry, an adaption of a Twyrian Green interferometer and grazing incidence interferometry for the testing of aspheric surfaces of optical components.

Descriptors: INTERFEROMETRY LIGHT; LENSES ASPHERICAL MIRRORS

Identifiers: INTERFEROMETRIC TESTING; ASPHERIC SURFACES; LATERAL SHEARING INTERFEROMETRY; TWYRIAN GREEN INTERFEROMETER; GRAZING INCIDENCE INTERFEROMETRY; OPTICAL COMPONENTS

BRIERS, J.D.
"SELF-COMPENSATION OF ERRORS IN LATERAL SHEARING INTERFEROMETER"
Opt. Commun., 4, 69 (1971)
No abstract provided.

BRIERS, J.D.
"INTERFEROMETRIC TESTING OF OPTICAL SYSTEMS AND COMPONENTS: A REVIEW"
Opt. Laser Technol., 4, 28 (1972)
No abstract provided.

BROWN, D.S.
"A SHEARING INTERFEROMETER WITH FIXED SHEAR AND ITS APPLICATION TO SOME PROBLEMS IN THE TESTING OF ASTRO-OPTICS"
Proc. Phys. Soc. Lond., B67, 232 (1954)
No abstract provided.

BROWN, D.S.
"THE APPLICATION OF SHEARING INTERFEROMETRY TO ROUTINE OPTICAL TESTING"
J. Sci. Instrum., 32, 137 (955)
No abstract provided.

BRUNING, J.H., HERRIOTT, D.R., GALLAGHER, J.E., ROSENFELD, D.P., WHITE, A.D., and BRANGACCIO, D.J.
"DIGITAL WAVEFRONT MEASURING INTERFEROMETER FOR TESTING OPTICAL SURFACES AND LENSES"
App. Opt., 13, 2693 (1974)
A system is described for measuring optical components to Lamda/100 by averaging many wavefronts to minimize the effects of air turbulence, vibrations, and thermal drifts. Errors of the interferometer are explicitly measured and compensated before the wavefront, point spread function, modulation transfer function, or optical transfer functon are displayed. In essence, a scheme for digital measurement of an interference pattern with a real time data display has been successfully applied to a Twyman-Green interferometer. Only a minute or so is required to optimize data and give final performance of assembled diffraction limited optical systems. The system is convenient for routine process control (3 Refs.).
Descriptors: LIGHT INTERFEROMETERS; OPTICAL TESTING; LENSES
Identifiers: TWYMAN GREEN INTERFEROMETER;

DIGITAL WAVEFRONT MEASURING INTERFEROMETER; TESTING; OPTICAL SURFACES; LENSES; AIR TURBULENCE; THERMAL DRIFTS; VIBRATIONS; ERRORS; WAVEFRONT; POINT SPREAD FUNCTION; MODULATION TRANSFER FUNCTION; OPTICAL TRANSFER FUNCTION; REAL TIME DATA DISPLAY; ASSEMBLED DIFFRACTION LIMITED OPTICAL SYSTEMS; ROUTINE PROCESS CONTROL

BRYNGDAHL, O.,
"APPLICATIONS OF SHEARING INTERFEROMETRY"
Progress in Optics, 4, 39, (1964)
No abstract provided.

DE VANY, A. S.,
"SOME ASPECTS OF INTERFEROMETRIC TESTING AND OPTICAL FIGURING,"
Appl. Opt., 4, 831, 1965
No abstract provided.

DE VANY, A. S.
"QUASI-RONCHIGRAMS AS MIRROR TRANSITIVE IMAGES OF SHEARING INTERFEROGRAMS"
Appl. Opt., 9, 1477 (1970)
No abstract provided.

DONATH, E. and CARLOUGH, W.
"RADIAL SHEARING INTERFEROMETER"
J. Opt. Soc. Am., 53, 395, (1963)
No abstract provided.

DREW, R.L.
"A SIMPLIFIED SHEARING INTERFEROMETER"
Proc. Phys. Soc. Lond., 64, 1005 (1951)
No abstract provided.

GATES, J. W.
"REVERSE SHEARING INTERFEROMETRY"
Nature, 176, 359 (1955)
No abstract provided.

HABERLAND, E.
"UBER LINSENFEHLER FUR SCHIEFE BUSCHEL"
(UPON THE LENS ABERATION WITH OBLIQUE BUNDLES)
Z. Phys., 24, 285 (1924)

No abstract provided.

HARIHARAN, P. and SEN, D.,
"TRIANGULAR PATH MACRO-INTERFEROMETER"
J. Opt. Soc. Am., 49, 1105 (1959)
No abstract provided.

HARIHARAN, P. and SEN, D.,
"CYCLIC SHEARING INTERFEROMETER"
J. Sci. Instrum., 37, 374 (1960)
No abstract provided.

HARIHARAN, P., STEEL, W. H., AND WYANT, J. C.,
"DOUBLE GRATING INTERFEROMETER WITH VARIABLE LATERAL SHEAR"
Opt. Commun., 11, 317, (1974)
No abstract provided.

HARIHARAN, P.,
"SIMPLE LASER INTERFEROMETER WITH VARIABLE SHEAR AND TILT"
Appl. Opt., 14, 1056 (1975)
No abstract provided.

KELLEY, J. G., and HARGREAVES, R. A.,
"A RUGGED INEXPENSIVE SHEARING INTERFEROMETER,"
Appl. Opt., 9, 948 (1970)
A portable, rugged, inexpensive shearing interferometer is described and evaluated. Originally intended for application to plasma and flow analysis, it is also a suitable instructional aid. The shearing is obtained by the offset of the reflection from the first surface of a mirror relative to the reflection from the second surface when the mirror is set at an angle to the illuminating beam. The sensitivity is equivalent to that of a schlieren system. However, no schlieren quality components are involved and there are no critical adjustments or dimensions.

KOMISSARUK, V.A.
"INVESTIGATION OF WAVEFRONT ABERRATIONS OF OPTICAL SYSTEMS USING THREE BEAM INTERFERENCE"
Opt. Spectrosc., 16, 571 (1964)
No abstract provided.

KOMISSARUK, V. A.,
"THE DISPLACEMENT INTERFEROGRAM IN THE CASE OF A WAVEFRONT HAVING ROTATIONAL SYMMETRY"
Sov. J. Opt. Technol., 36, 456 (1969).
No abstract provided.

LANGENBECK, P.,
"IMPROVED COLLIMATION TEST"
Appl. Opt., 9, 2590 (1970)
No abstract provided.

LANGENBECK, P.
"MODIFYING A SHEAR INTERFEROMETER TO OBTAIN A NEUTRAL REFERENCE BEAM"
J. Opt. Soc. Am., 61, 172 (1971)
No abstract provided.

LENOUVEL, L. and LENOUVEL, F.,
"ETUDE DES FAISCEAUX CONVERGENTS,"
(CONVERGENT BEAMS STUDY.)
Rev. Opt. Theor. Insrum., 17, 350 (1938)
No abstract provided.

LINNIK, W.,
"SIMPLE INTERFEROMETER TO TEST OPTICAL SYSTEMS"
Z. Instrumentenkd, 54, 463 (1934)
No abstract provided.

LOHMANN, A. and BRYNGDAHL, O.,
"A LATERAL WAVEFRONT SHEARING INTERFEROMETER WITH VARIABLE SHEAR"
Appl. Opt., 6, 1934 (1967)
No abstract provided.

MALACARA, D.
"HOLOGRAPHIC LATERAL SHEAR INTERFEROMETER"
Appl. Opt., 15, 2695 (1976)
Describes a new type of holographic lateral shear interferometer with some features similar to those of a holographic interferometer due to Wyant (See Ibid., Vol. 12, No. 9, P. 2057 (1973). Application to testing lenses and spherical and aspherical surfaces is described (4 Refs.).
Descriptors: HOLOGRAPHIC INTERFEROMETRY; OPTICAL TESTING; LIGHT INTERFEROMETERS
Identifiers: HOLOGRAPHIC LATERAL SHEAR INTERFEROMETER; TESTING; LENSES; ASPHERICAL SURFACES; SPHERICAL SURFACES

MALACARA. D. and MENDEZ, M.
"LATERAL SHEARING INTERFEROMETRY OF WAVEFRONTS HAVING ROTATIONAL SYMMETRY"
Opt. Acta, 15, 59 (1968)
No abstract provided.

MALACARA, D., Cornejo, A., and MURTY, M. V. R. K.,
"A SHEARING INTERFEROMETER FOR CONVERGENT OR DIVERGENT BEAMS"
Bolt. Inst. Tonantzintla, 1, 233 (1975)
A simple lateral shearing interferometer using a single prismatic lens is described. This instrument is a modification of the Murty interferometer to permit the testing of convergent or divergent wavefronts (1 Ref.).
DESCRIPTORS: OPTICAL TESTING; OPTICAL TESTING; LIGHT INTERFEROMETERS
Identifiers: SHEARING INTERFEROMETER; DIVERGENT BEAMS; LATERAL SHEARING INTERFEROMETER; SINGLE PRISMATIC LENS; CONVERGENT BEAMS; OPTICAL TESTING

MALACARA, D.,
"TESTING OF ASTRONOMICAL MIRRORS"
Opt. Shop Notebook, IX, 96 (1975)
No abstract provided.

MALACARA, D. and MALLICK, S.,
"HOLOGRAPHIC LATERAL SHEAR INTERFEROMETER"
Appl. Opt., 15, 2695 (1976)
A new type of lateral shear holographic interferometer is described. It can be used to test lenses as well as spherical and aspherical surfaces. A null pattern with straight fringes can be obtained for an aspherical surface, provided one has a prototype that can be used for making the hologram.

MURTY, M. V. R. K.,
"SOME MODIFICATIONS OF THE JAMIN INTERFEROMETER USEFUL IN OPTICAL TESTING"
Appl. Opt., 3, 535, (1964).
No abstract provided.

MURTY, M.V.R.K.
"THE USE OF A SINGLE PLANE PARALLEL PLATE AS A LATERAL SHEARING INTERFEROMETER WITH A VISIBLE GAS LASER SOURCE"
Appl. Opt., 3, 531, (1964)
No abstract provided.

MURTY, M.V.R.K.
"INTERFEROMETRY APPLIED TO TESTING OF OPTICS"
Bull. Opt. Soc., 1, 29, (1967)
No abstract provided.

MURTY, M.V.R.K.
"FABRICATION OF FIXED SHEAR CUBE TYPE SHEARING INTERFEROMETER"
Bull. Opt. Soc., 3, 55, (1969)
No abstract provided.

MURTY, M.V.R.K.
"A COMPACT LATERAL SHEARING INTERFEROMETER BASED ON THE MICHELSON INTERFEROMETER"
Appl. Opt., 9, 1146, (1970)
No abstract provided.

MURTY, M. V. R. K.,
"A SIMPLE METHOD OF INTRODUCING TILT IN THE RONCHI AND CUBE TYPE OF SHEARING INTERFEROMETERS"
Bull. Opt. Soc., 5, 1 (1971)
No abstract provided.

MURTY, M. V. R. K.,
"LATERAL SHEARING INTERFEROMETERS - CHAPTER 4"
Optical Shop Testing, Malacara, D., Ed. (1978)

4.1 Introduction
4.2 Considerations Regarding Coherence Properties of the Light Source
4.3 Brief Theory of Lateral Shearing Interferometry
  4.3.1 Considerations of Lateral Shear in Relation to Primary Aberrations
4.4 Evaluation of an Unknown Wavefront
4.5 Lateral Shearing Interferometers in Collimated Light (White Light Compensated)
  4.5.1 Arrangements Based on the Jamin Interferometer
  4.5.2 Arrangements Based on the Michelson Interferometer
  4.5.3 Arrangements Based on a Cylic Interferometer
  4.5.4 Arrangements Based on the Mach-Zender Interferometer
4.6 Lateral Shearing Interferometers in Convergent Light (White Light Compensated)
  4.6.1 Arrangements Based on the Michelson Interferometer
  4.6.2 Arrangements Based on the Mach-Zender Interferometer
4.7 Lateral Shearing Interferometers Using Lasers
  4.7.1 Other Applications of the Parallel Plate

Interferometer
4.8 Other Types of Lateral Shearing Interferometers
4.8.1 Lateral Shearing Interferometers Based on Diffraction
4.8.2 Lateral Shearing Interferometers Based on Polarization

NYSSONEN, D., and JERKE, J. M.
"LENS TESTING WITH A SIMPLE WAVEFRONT SHEARING INTERFEROMETER
Appl. Opt., 12, 2061 (1973)
No abstract provided.

JERKE, J.M.
"LENS TESTING WITH A SIMPLE WAVEFRONT SHEARING INTERFEROMETER",
Appl. Opt., 12, 2061 (1973)
A lens-testing system using a simple wavefront shearing interferometer is described. This simple cube interferometer has all the interferometric adjustments built in at manufacture. In contrast to most interferometric test systems, the wavefront shearing interferometer is inexpensive, portable, relatively insensitive to vibration. Does not need laser illumination, and requires only a minimum of experimental time and operational expertise. Regarding of the interferograms and subsequent data reduction require the major effort in testing with the wavefront shearing interferometer. However, with automatic scanning of the interferograms and a high-speed electronic computer to perform the analysis, the data reduction may be completely automated. Operation of the wavefront shearing interferometer is described together with the method of data reduction. Experimental results are also presented (21 Refs.).
Descriptors: LENSES; OPTICAL TESTING; LIGHT INTERFEROMETRY; COMPUTER-AIDED ANALYSIS
Identifiers: LENS TESTING; WAVEFRONT SHEARING INTERFEROMETER; COMPUTER AIDED ANALYSIS

RIMMER, M. .,
" A METHOD FOR EVALUATING LATERAL SHEARING INTERFEROGRAMS"
Itek Corp. Internal Report 72-5802-1 (1972)
(
No abstract provided.

RIMMER, M.P. and WYANT, J.C.
"EVALUATION OF LARGE ABERRATIONS USING A LATERAL-SHEAR INTERFEROMETER"
HAVING VARIABLE SHEAR"
Appl. Opt., 14, 142, (1975)
A variable shear lateral shearing interferometer consisting of two holographically produced crossed diffraction gratings is used to test nonrotationally symmetric wavefronts having aberrations greater than 100 wavelengths and slope variations of

more than 400 wavelengths/diameter. Comparisons are made with results of Twyman-Green interferometric tests for wavefront aberrations can be measured as accurately with the lateral-shear interferometer as with the Twyman-Green interferometer and that aberrations that cannot be measured at all with a Tywman-Green interferometer can be measured to about 1

RONCHI, V.
"FORTY YEARS OF HISTORY OF A GRATING INTERFEROMETER"
Appl. Opt., 3, 437 (1964)
No abstract provided.

SAUNDERS, J.B.
"A SIMPLIFIED WAVEFRONT SHEARING INTERFEROMETER AND UNIQUE METHOD OF EVALUATING ANY CONVERGING WAVEFRONT"
J. Opt. Soc. Am., 51, 1467 (1961)
No abstract provided.

SAUNDERS. J.B.
"SOME APPLICATIONS OF THE WAVEFRONT SHEARING INTERFEROMETER"
Jap. J. Appl. Phys., 4, Suppl. 1, 99 (1965)
(Proceedings of the Conference on Photographic and Spectroscopic Optics, Tokyo and Kyoto, 1964)
No abstract provided.

SAUNDERS, J.B.
"MEASUREMENT OF WAVEFRONTS WITHOUT A REFERENCE STANDARD. PART 1: THE WAVEFRONT SHEARING INTERFEROMETER"
J. Res. Nat. Bur. Stand., 65, 239 (1961)
No abstract provided.

SAUNDERS, J.B.
"MEASUREMENT OF WAVEFRONTS WITHOUT A REFERENCE STANDARD. PART II: THE WAVEFRONT REVERSING INTERFEROMETER"
J. Res. Nat. Bur. Stand., 66, 29 (1962)
No abstract provided.

SAUNDERS, J.B.
"A SIMPLE INEXPENSIVE WAVEFRONT SHEARING INTERFEROMETER"
Appl. Opt., 6, 1581 (1967)
No abstract provided.

SAUNDERS, J.B., and BRUENING, R.J.,
"A NEW INTERFEROMETRIC TEST AND ITS APPLICATIONS TO THE 84-INCH REFLECTING TELESCOPE AT KITT PEAK NATIONAL OBSERVATORY"
Astron. J., 73, 415 (1968)
No abstract provided.

SAUNDERS, J.B.
"A SIMPLE INTERFEROMETRIC METHOD FOR WORKSHOP TESTING OF OPTICS"
Appl. Opt., 9, 1623, (1970)
9, 1623
A simple step-by-step method is given for deriving the shape of wavefronts from data obtained with a wavefront shearing interferometer. No mathematics, other arithmetic, is used. The result is the accurate deviation of the wavefront from a reference sphere that coincides with it at three chosen reference points. The method is intended primarily for the use of opticians workshops, but is also quite practical for the final testing of optics for performance rating. A method is given by which an optician can evaluate an optical surface by comparing the interferogram, produced by it and a known prism interferometer, with a drawing of the desired interferogram. This procedure is analagous to using test plates for visual inspection of optical surfaces.
Descriptors: OPTICAL INTERFEROMETERS, TESTS
Identifiers: NTISCOMNBS

SAUNDERS, J.B.
"A SIMPLE INTERFEROMETRIC METHOD FOR WORKSHOP TESTING OF OPTICS"
Appl. Opt., 9, 1623, (1970)
A simple step-by-step method is given for deriving the shapes of wavefronts from data obtained with a wavefront shearing interferometer. No mathematics, other than arithmetic, is used. The result is the accurate deviation of the wavefront from a reference sphere that coincides with it at three chosen reference points. The method is intended primarily for the use of opticians in optical workshops, but is also quite practical for the final testing of optics for performance rating. A method given by which an optician can evaluate an optical surface by comparing the interferogram produced by it and a know prism interferometer, with a drawing of the desired interferogram. This procedure is analogous to using test plates for visual inspection of optical surfaces.

SEN, D., and PUNTAMBEKAR, P.N.
"SHEARING INTERFEROMETER FOR TESTING CORNER CUBES AND RIGHT ANGLE PRISMS"
Appl. Opt., 5, 1009 (1966)
No abstract provided.

SWING, R.E.
"THE CASE FOR THE PUPIL FUNCTION"
Soc. Photo-Optical Instrumentation Engrs. (1974)
The pupil function has been chosen as the basis for measurement of optical

performance; from this, transfer function, impulse response(s) and the lens aberrations are calculated. The measurement is implemented through the wave-front shearing interferometer. This device also has the capability of testing microscope optics (37 Refs.).

Descriptors: LENSES; TRANSFER FUNCTIONS; ABERRATIONS; OPTICAL IMAGES; OPTICAL INSTRUMENT TESTING; LIGHT INTERFEROMETRY

Identifiers: WAVE FRONT SHEARING INTERFEROMETER; PUPIL FUNCTION; OPTICAL PERFORMANCE; TRANSFER FUNCTIONS; IMPULSE RESPONSE; LENS ABERRATIONS; MICROSCOPE OPTICS

TABOADA, J.
"LATERAL SHEARING INTERFEROMETRIC TECHNIQUE FOR TRANSPARENCY DISTORTION ANALYSIS"
Appl. Opt., 16, 2603, (1977)
No abstract provided.

TANNER, L.H.
"SOME LASER INTERFEROMETERS FOR USE IN FLUID MECHANICS"
J. Sci. Instrum., 42, 834 (1965).
No abstract provided.

THOMAS, D.A. and WYANT, J.C.
"HIGH EFFICIENCY GRATING LATERAL SHEAR INTERFEROMETER"
Opt. Eng., 15, 477 (1976)
The use of dichromated gelatin for holographically recording the component single frequency gratings of a high efficiency grating lateral shear interferometer is described. Interferograms obtained using a grating lateral shear interferometer simultaneously having a diffraction efficiency of 30 are presented.

VAN ROOYEN, E.
"DESIGN FOR A VARIABLE SHEAR PRISM INTERFEROMETER"
Appl. Opt., 7, 2423 (1968)
No abstract provided.

VAN ROOYEN, E., and VAN HOUTEN, H.G.
"DESIGN OF A WAVEFRONT SHEARING INTERFEROMETER USEFUL FOR TESTING LARGE APERTURE OPTICAL SYSTEMS"
Appl. Opt., 8, 91 (1969)
The construction of a Drew type variable shear wavefront shearing interferometer, useful for testing optical systems of large aperture and short focal length, is described. The mechanical arrangement, used for adjustment of the mirrors and the dividing plate, and a novel arrangement to achieve white light compensation easily, are described. Shared interferograms of some lenses are shown.

WYANT, J.C.
"DOUBLE FREQUENCY GRATING LATERAL SHEAR INTERFEROMETER"
Appl. Opt., 12, 2057 (1973)
No abstract provided.

WYANT, J.C.
"USE OF AN AC HETERODYNE LATERAL SHEAR INTERFEROMETER WITH REAL-TIME WAVEFRONT CORRECTION SYSTEMS
Appl. Opt., 14, 2622 (1975)
An analysis is performed to determine the accuracy with which an ac heterodyne lateral shear interferometer can measure wavefront aberrations if a white light extended source is used with the interferometer, and shot noise is the predominate noise source. The analysis shows that for uniform circular or square sources larger than a derived minimum size, the wavefront measurement accuracy depends only upon the radiance of the source and not upon the angular subtense of the source. For a 10msec integration time, a 25-cm collecting area, and a source radiance of 10 W/m^2-sr the rms wavefront error is approximately 1/30 wave, assuming the signal is shot noise limited. It is shown that for both uniform circular and square sources an optimum shear distance is approximately 1/2 the aperture diameter required to resolve the light source. Comments are made on the optimum shear for nonuniform radiance distributions.

WYANT, J.C. AND SMITH, F.D.
"INTERFEROMETER FOR MEASURING POWER DISTRIBUTION OF OPHTHALMIC LENSES"
Appl. Opt., 14, 1607 (1975)
The use of a lateral shear interferometer in measuring the power variation of ophthalmic lenses is described and demonstrated. It is shown that an appropriate lateral shear interferometer directly measures the power variation of an ophthalmic lens. If the opthalmic lens has a toric surface, the power for each axis can be measured separately. Individual surfaces can be tested, as well as the whole lens or the different segments of a multifocal lens. The sensitivity of the test can be selected by varying the amount of lateral shear. Because of the demonstrated simple relationship between fringe spacing and dioptric power, qualitative examination of the fringes has proved a useful adjunct to conventional quality control methods.

YOKOZEDI, S., AND SUZUKI, T.
"SHEARING INTERFEROMETER USING THE GRATING AS THE BEAM SPLITTER"
Appl. Opt., 10, 1575 (1971)
No abstract provided.

4.2 KOSTER'S PRISM INTERFEROMETER

SAUNDERS, J.
"INVERTING INTERFEROMETER"
J. Opt. Soc. Am., 45, 133 (1955)
No abstract provided.

SAUNDERS, J.B.
"INTERFEROMETER TEST OF THE 26-INCH REFRACTOR AT LEANDER MCCORMICK OBSERVATORY"
Aston. J., 69, 449 (1964)
No abstract provided.

SAUNDERS, J.B.
"WAVEFRONT SHEARING PRISM INTERFEROMETER"
J. Res. Nat. Bur. Stand., 68, 155 (1964)
No abstract provided.

4.3 MURTY INTERFEROMETER

DE VANY, A.S.
"USNG A MURTY INTERFEROMETER FOR TESTING THE HOMOGENEITY OF TEST SAMPLES OF OPTICAL MATERIALS"
Appl. Opt., 10, 1459 (1971)
No abstract provided.

DE VANY, A.S.
"QUASI-RONCHIGRAMS AS MIRROR TRANSITIVE IMAGES OF SHEARING INTERFEROGRAMS"
Appl. Opt., 9, 1477 (1970)
No abstract provided.

DE VANY, A.S.
"SCANNING MURTY INTERFEROMETER FOR OPTICAL TESTING"
Appl. Opt., 11, 1467 (1972)
No abstract provided.

DUTTON, D., CORNEJO, A., AND LATTA, M.
"SEMIAUTOMATIC METHOD FOR INTERPRETING SHEARING INTERFEROGRAMS"
Appl. Opt., 7, 125 (1968)
No abstract provided.

MURTY, M.V.R.K.
"THE USE OF A SINGLE PLANE PARALLEL PLATE AS A LATERAL SHEARING INTERFEROMETER WITH A VISIBLE GAS LASER SOURCE"
Appl. Opt., 3, 531 (1964)
No abstract provided.

MURTY, M.V.R.K., AND MALACARA, D.
"SOME APPLICATIONS OF THE GAS LASER AS A SOURCE OF LIGHT FOR THE TESTING OF OPTICAL SYSTEMS"
Appl. Phys., 4, Suppl. 1, 106 (1965)
No abstract provided.

WYANT, J.C.
"INTERFEROMETER FOR MEASURING POWER DISTRIBUTION OF OPHTHALMIC LENSES"
Itek Corp. Internal Report OLTN 70-5 (1971)
No abstract provided.

4.4 BIREFRINGENT AND POLARIZATION INTERFEROMETERS

DYSON, J.
"VERY STABLE COMMON-PATH INTERFEROMETER AND APPLICATIONS"
J. Opt. Soc. Am., 53, 690 (1963)
No abstract provided.

FRANCON, M.
"INTERFEROMETRE POUT L'ETUDE EN LUMIERE BLANCHE DES VARIATIONS QUELCONQUES DE CHEMIN OPTIQUE"
(INTERFEROMETER FOR THE STUDY IN WHITE LIGHT OF VARIATIONS OF OPTICAL PATH"
C.R. Acad. Sci., 234, 311 (1952)
No abstract provided.

FRANCON, M. and JORDERY, M.
"APPLICATION DES INTERFERENCES PAR DOUBLE REFRACTION A L'ETUDE DES ABERRATIONS"
(APPLICATION OF INTERFERENCE BY DOUBLE REFRACTION TO THE STUDY OF ABERRATIONS)
Rev. Opt. Theor. Instrum., 32, 601 (1953)
No abstract provided.

MALLICK, S., and ROBLIN, M.L.
"SHEARING INTERFEROMETRY BY WAVEFRONT RECONSTRUCTION USING A SINGLE EXPOSURE"
Appl. Phys. Lett., 14, 61 (1969)
No abstract provided.

TAKASAKI, H.
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Appl. Opt., 13 2035 (1974)
A new type of radial shear interferometer based on the imaging properties of Gabor zone plates is described. This interferometer is stable, easily constructed, and is a useful instrument in optical testing.

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J. Opt. Soc. Am., 51, 1307 (1961)
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Appl. Opt., 13, 1781 (1974)
The procedure for computing a radial shearing interferometric pattern is given. The

interferometric pattern is analyzed to obtain the wavefront shape. Restricting the discussion to wavefronts having rotational symmetry, we give two different methods of finding the wavefront. One approach is to scan along a diameter of the interferometric pattern and the other is to examine the shape of the fringes. The relative sensitivity of a radial shearing interferometer with respect to that of a Twyman-Green interferometer is also analyzed.

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- 5.1 Introduction
- 5.2 Radial Shear Interferometers
  - 5.2.1 Single-Pass Radial Shear Interferometers
  - 5.2.2 Double-Pass Radial Shear Interferometers
  - 5.2.3 Laser Radial Shear Interferometers
- 5.3 Rotational Shear Interferometers
  - 5.3.1 Source Size Uncompensated Rotational Shear Interferometers
  - 5.3.2 Source Size Compensated Rotational Shear Interferometers
- 5.4 Reversal Shear Interferometers
  - 5.4.1 Some Reversal Shear Interferometers

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Appl. Opt., 3, 853, (1964)
A brief review of radial shearing interferometers as well as a logical development of various types of these interferometers is presented. The discussion considers two types of interferometers. One type essentially introduces a radial shear in collimated light while in the other type a radial shear is introduced in converging light. Finally, a compact interferometer is described. This interferometer uses the Snell's law of refraction for obtaining radial shear and consists of two identical prisms which make up a pentaprism. In one of the prisms, a hemispherical depression is made, and this is the basic element that introduces radial shear.

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"INTERFEROMETRY APPLIED TO TESTING TO OPTICS"
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Appl. Opt., 12, 2765 (1973)
Radial shearing interferometers have been devised by several workers earlier. All of them were based on conventional light sources, and consequently full white light compensation was required. It is possible to devise several schemes of radial shearing interferometers ignoring the condition of white light compensation when a laser source is used in place of a conventional source. Some of these arrangements are described in the present paper.

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Appl. Opt., 5, 1009 (1966)
A wavefront reversing interferometer and an inverting interferometer are described for use in testing corner cubes and right angle prisms. Both the interferometers are stable, easy to adjust, and require comparatively simple setup. They have adequate sensitivity for measuring divergence of the reflected wavefronts, but do not give directly the symmetrical errors of the prisms. With the inverting interferometer, the latter can be determined by changing the shear. Methods are suggested for testing the

prisms during manufacturer and correcting their defects by use of these interferometers.

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Appl. Opt., 11, 2613 (1972)
The the 'y and experimental evidence of a shearing interferometer based on the Talbot effect are presented. Multiple-shearing interferences are obtained that can be reduced to triple-shearing or double-shearing interferences by the addition of simple spatial filtering. When the shear is less than the width of the details in the object, these interferences become either the second or first derivative of the object under tests, respectively. Either lateral or constant radial shear can be introduced by choosing Ronchi rulings or circular gratings. Thus both lateral and radial derivatives are easily obtained. If white light is used as a source, color fringes of high contrast are observed.

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J. Sci. Instrum., 42, 102 (1965)
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Opt. Acta, 17, 721 (1970)
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Opt. Commun., 14 108, (1975)
A suitable designed thick lens can be used with a laser source as a radial-shear interferometer. One interfering beam is transmitted directly; the other is reflected once at each surface. Applications for testing optical instruments are discussed (2 Refs.).
Descriptors: LIGHT INTERFEROMETERS; LENSES; OPTICAL INSTRUMENT TESTING
Identifiers: OPTICAL INSTRUMENT TESTING; THICK LENS; LASER SOURCE; INTERFERING BEAM;

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(INTERFERENCE METHOD FOR DETERMINATION OF ABERRATIONS OF OPTICAL SYSTEMS)
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Appl. Opt., 15, 2705 (1976)
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"AN INTERFERENCE METHOD FOR DETERMINING THE DEGREE OF PARALLELISM OF (LASER) SURFACES"
Appl. Opt., 7, 923 (1968)
A method for measuring the angle between two nearly parallel surfaces is presented. Convenient to use, the method has ample brightness and sensitivity for use in aligning the various surfaces often found in laser cavities. A cw laser is focused to provide a point source of light which illuminates the two surfaces in question. The reflected light beams form an interference pattern from which the angle between the surfaces can be easily measured. A simple equation is given relating the fringe position to angular separation.

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"TRANSMISSION PROFILE OF A FABRY-PEROT INTERFEROMETER SUFFERING FROM ASYMMETRIC SURFACE DEFECTS"
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Appl. Opt., 9, 2053 (1970)
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6.3.1. Conditions for Fringe Formation
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6.4 Fringes of Equal Chromatic Order
6.5 Reduction of Fringe Interval in Multiple-Beam Interferometry
6.6 Plane Parallel Fabry-Perot Interferometer
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6.7 Tolansky Fringes with Fabry-Perot Interferometer
6.8 Multiple-Beam Interferometer for Curved Surfaces
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6.9.1 Coupled Interferometer
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8.2 Foucault or Knife-Edge Test
 8.2.1 Description
 8.2.2 Geometrical Theory
 8.2.3 Physical Theory
8.3 Wire Test
 8.3.1 Geometrical Theory
 8.3.2 Physical Theory
8.4 Platzeck-Gaviola Test
 8.4.1 Geometrical Theory
8.5 Phase Modulation Tests
 8.5.1 Zernike Test and Its Relation to the Smartt Interferometer
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The double wire testing of 5.5 aspheric mirrors, 15.5 cm or larger, merit, further description. The sensitiveness of the test increases for faster f ratio values. The double wire apparatus consisted of two 0.10-mm wires, 10 mm apart, carrying an 0.08-mm pin-hole source. The double wire tube holder is placed behind a 50 50 aluminized pellicle, and the pin hole is projected on the pellicle by a small fast condenser system.

The testing of aspheric mirrors with this on-axis apparatus is similar to testing with a knife-edge, concave mirror, or using autocollimating setups with an optical flat. In the double wire test, the first wire split into a Ronchi line encircling any radial zone depending upon the position where the test apparatus is placed along the radius of curvature of the mirror. The second wire served as a reference line keeping the test unit in the axial plane while measuring the sagital slopes of the spheric mirror. The pellicle and second reference wire is important; it keeps the pin-hole light source and wires on-axis constantly checks that the bifurcating central line remains centrally positioned while the steep sagittae are measured for f 3.0 or faster. The general procedure is: first, mark off with a felt pen 10-mm radial zones across the diameter of the mirror starting in the middle. Second, locate the bifurcating Ronchi line projected on the mirror, which is caused by the first wire. Third, move the test apparatus along the radius of curvature of the mirror and observe how precisely the Ronch line can be positioned on the measured radial zones. Fourth, locate the reference second wire near the eye, using it to keep the test unit from translating in the axial plane while measuring. Fifth, record the measured zonal departures starting at the extreme edge (which we generally assume to be correct).

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9 RONCHI AND LOWER TESTS

9.1 RONCHI TEST

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Appl. Opt., 9, 1897 (1970)
The test of a mirror by the Ronchi method has shown to be very useful for testing concave aspherical mirrors. The analysis of a Ronchi pattern in order to find the experimental deviations of a given mirror whose theoretical shape is known, and the accuracy that can be obtained are described here.

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CHAPTER 9. RONCHI TEST
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9.1 Introduction
9.1.1 Historical Introduction
9.2 Geometrical Theory
9.2.1 Ronchi Patterns for Primary Aberrations
9.2.2 Ronchi Patterns for Aspherical Surfaces
9.2.3 Null Ronchi Rulings
9.3 Wavefront Shape Determination
9.3.1 General Case
9.3.2 Surfaces with Rotational Symmetry
9.4 Physical Theory
9.4.1 Mathematical Treatment
9.4.2 Physical versus Geometrical Theory
9.5 Practical Aspects of the Ronchi Test
9.6 Some Related Tests
9.6.1 Concentric Circular Grid
9.6.2 Scanning Ronchi Test
9.6.3 Side Band Ronchi Test
9.6.4 Lower Test

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Appl. Opt., 4, 831 (1965)
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Appl. Opt., 9, 1219 (1970)
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Appl. Opt., 9, 1944 (1970)
The correlation existing between Ronchigrams and interferograms seems not to be fully explained. In this note, we offer an interpretation of the correlation: quasi-Ronchigrams are mirror transitive images of interferograms. Of the many methods of testing spherical aberration by analysis of the wavefront information, each has its limitations. The several types of interferometers known are the nonshearing type represented by the LUPI (laser unequal path interferometer) and Twyman-Green, the shearing type represented by Bates, and the laser type by Murty. The interferogram we use is from the LUPI.

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Appl. Opt., 9, 1219 (1970)
In a previous paper the Author described the Ronchigrams formed by a lens system having residual spherical aberration (see Abst. A28271 of 1965). In this paper he discussed the reflective mirror transitive images observed in an interferogram from which the symmetrical Ronchigram can be developed.
Descriptors: LENSES; INTERFEROMETRY LIGHT

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DE VANY, A.S.
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Bolt. Inst. Tonantzintla, 1, 295 (1975)

Develops a representation of Ronchigrams and Focograms to reveal the symmetries and other relationships in an array of patterns around one central null pattern. The Ronchigrams and Focograms of a lens system with residual spherical aberration are depicted within equal areas. The central area (center to 0.707 zone) is compared with an equal peripheral area (0.707 zone to the edge). Secondly, the paper examines some aspects of the correlation between Ronchigrams and Focograms, and shows how this information can be of value in figuring lenses in the Optical Shop (4 Refs.).

Descriptors: OPTICAL INSTRUMENT TESTING; LENSES
Identifiers: FOCOGRAMS; RONCHIGRAMS; CENTRAL NULL PATTERN; LENS SYSTEM

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Opt. Eng., 14, 520 (1975)
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Descriptors: DIFFRACTION GRATINGS; ABERRATIONS; OPTICAL DESIGN TECHNIQUES; OPTICAL TESTING;
Identifiers: SPOT DIAGRAMS; PARAXIAL FOCUS; PARABOLOID; NULL RONCHI GRATINGS; THRID ORDER SPHERICAL ABERRATION; LENS TESTING

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Appl. Opt., 4, 1371 (1965)
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MMGT: BIBLIOGRAPHY ON OPTICAL TESTING WITH APPENDIX.(U)
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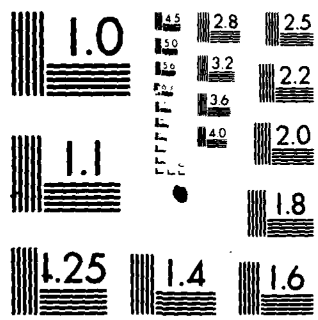

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963-A

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<u>Appl. Opt., 10</u>, 679 (1970)
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"NULL RONCHI TEST FOR ASPHERICAL SURFACES"
<u>Appl. Opt., 13</u>, 1778 (1974)
Proposes a Ronchi ruling with calculated curved lines the curvature of which compensates for asphericity of the test surface and thereby produces straight fringes of constant thickness which are more easily matched during the figuring process than the fringes of the normal Ronchi test. A monochromatic point source (Laser) is necessary for the proposed test. results for a paraboloidal mirror are given (3 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; LIGHT DIFFRACTION; DIFFRACTION GRATINGS; ASPHERICAL LENSES; MIRRORS
Identifiers: NULL RONCHI TEST; ASPHERICAL SURFACES; FIGURING PROCESS; MONOCHROMATIC POINT SOURCE; PARABOLOIDAL MIRROR; OPTICAL TESTING

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<u>Opt. Spectra, 8</u>, 54 (1974)
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<u>Bol. Inst. Tonantzintla, 1</u>, 193 (1974)
The Talbot effect consists of the formation of a well defined image of a diffraction grating at a certain distance from it. This effect can be generalized for use with either convergent or divergent light. Therefore, this effect can be utilized to obtain well defined fringes in the Ronchi test (3 Refs.).
Descriptors: OPTICAL IMAGES; OPTICAL TESTING; LENSES; ASTRONOMICAL TECHNIQUES;DIFFRACTION GRATINGS
Identifiers: TALBOT EFFECT; RONCHI TEST; DIFFRACTION GRATING DIVERGENT LIGHT; CONVERGENT LIGHT; IMAGE FORMATION

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"SHAPE MEASUREMENT OF OPTICAL SURFACES WITH ROTATIONAL SYMMETRY USING RONCHIGRAMS"
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Optical Shop Notebook, IX, 96 (1975)
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"SIDE BAND RONCHI TEST"
Appl. Opt., 15, 2220 (1976)
Using holographic techniques a Ronchi ruling with carrier may be generated which has the property of giving highly defined Ronchi fringes, instead of the diffraction-blurred fringes produced in the normal test. This procedure can be generalized to include the case of circular fringes.

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Bol., Inst. Tonantzintla, 2, 91 (1976)
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"TESTING OF ASPHERICAL LENSES USING SIDE BAND RONCHI TEST"
Appl. Opt., 17, 17 (1978)
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Optical Shop Notebook, IX, 58 (1975)
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"RONCHI NULL TEST FOR PARABOLOIDS"
Sky Telesc., 48, 325 (1974)
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"RIASSUNTO DELLE APPLICAZIONI DEI RETICOLI ALLO STUDIO DELLE ABERRAZIONI DEI SISTEMI OTTICI"
(ABOUT THE APPLICATION OF GRATINGS TO THE STUDY OF THE ABERRATIONS OF OPTICAL SYSTEMS)
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Izv. Krym. Astrofiz. Obs., 45, 188 (1972)
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Note: Exact title or page number unknown.
Ann. Scuola Normale Superiore di Pisa, 15, (1923)
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L'Universo, 4, 10 (1923)
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11 STAR TEST

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Descriptors: OPTICAL DESIGN TECHNIQUES: LENSES; OPTICAL INSTRUMENT TESTING; HOLOGRAPHY; LIGHT INTERFEROMETRY

Identifiers: DESIGN; CONSTRUCTION; LARGE APERTURE OPTICAL SYSTEM; INTERFEROMETRIC TESTING TECHNIQUES; OPTICAL ELEMENTS; MOUNTING; MECHANICAL STABILITY; OPTICAL TESTS; MANGIN ELEMENTS; STAR TESTS; OTF; HOLOGRAPHIC TECHNIQUES; REFRACTOMG ELEMENTS; TEST PLATES; TWYMAN GREEN TECHNIQUE

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  - 11.1.5 Effects of Small Aberrations
- 11.2 Practical Aspects with Small Aberrations
  - 11.2.1 Effects to be Looked For
  - 11.2.2 The Light Source for Star Testing
  - 11.2.3 The Arrangement of the Optical System for Star Testing
  - 11.2.4 Microscope Objectives
  - 11.2.5 Can the Star Test Be Made Quantitative?
- 11.3 The Star Test with Large Aberrations
  - 11.3.1 Spherical Aberration
  - 11.3.2 Longitudinal Chromatical Aberration
  - 11.3.3 Axial Symmetry
  - 11.3.4 Astigmatism
  - 11.3.5 Distortion
  - 11.3.6 Nonnull Tests

12 HOLOGRAPHIC AND MOIRE TECHNIQUES

12.1 INTERFEROMETERS USING REAL HOLOGRAMS

BENOIT, MATHIEU, P.E., HORMIER, J., and THOMAS, A.
"CHARACTERIZATION AND CONTROL OF THREE DIMENSIONAL OBJECTS USING FRINGE PROJECTION TECHNIQUES"
Nouv. Rev. Opt., 6, 67 (1975)
No abstract provided.

BIEDERMANN, K.
"INFORMATION STORAGE MATERIALS FOR HOLOGRAPHY AND OPTICAL DATA PROCESSING"
Opt. Acta, 22, 103 (1975)
No abstract provided.

BIRCH, K.G. and GREEN, F.J.
"THE APPLICATION OF COMPUTER-GENERATED HOLOGRAMS TO TESTING OPTICAL ELEMENTS"
J. Phys., 5, 1982 (1972)
The application of computer-generated holograms to the interferometric testing of aspheric reflecting elements and spherical refracting elements has been investigated. A new technique for calculating the hologram and drawing it with a computer-controlled plotter has been demonstrated to provide holograms that reconstruct the required wavefront with an rms error of better than lambda/20, and interferometers developed that employ the holograms in a null-test of optical elements without impairing this accuracy (10 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; HOLOGRAPHY; COMPUTER APPLICATIONS; LENSES; MIRRORS
Identifiers: INTERFEROMETRIC TESTING; ASPHERIC REFLECTING ELEMENTS; SPHERICAL REFRACTING ELEMENTS; TESTING OPTICAL ELEMENTS; COMPUTER GENERATED HOLOGRAMS

BRYNGDAHL, O.
"SHEARING INTERFEROMETRY BY WAVEFRONT RECONSTRUCTION"
J. Opt. Soc. Am., 58, 865 (1968)
No abstract provided.

BRYNGDAHL, O.
"LONGITUDINALLY REVERSED SHEARING INTERFEROMETRY"
J. Opt. Soc. Am., 59, 142 (1969)
No abstract provided.

BRYNGDAHL, O.
"MULTIPLE BEAM INTERFEROMETRY BY WAVEFRONT RECONSTRUCTION"
J. Opt. Soc. Am., 59, 1171 (1969)
No abstract provided.

COLLIER, R.J., BURCKHARDT, C.B., and LIN, L.H.
OPTICAL HOLOGRAPHY
Academic Press, New York (1971)
No abstract provided.

EVANS, R.W., GALLAGHER, P., and RIMMER, D.A.
"THE DESIGN AND CONSTRUCTION OF A LARGE APERTURE OPTICAL SYSTEM USING HOLOGRAPHIC AND INTERFEROMETRIC TESTING TECHNIQUES"
Opt. and Laser Technol., 7, 203 (1975)
In the design and construction of a large aperture optical system problems were encountered in figuring the optical elements and in mounting them to achieve mechanical stability. The various optical tests which were used to help overcome these problems on a system comprising refracting, reflecting, and Mangin elements are described. Test plates, star tests, OTF, Twyman-Green, and holographic techniques were all used at some stage, and the application for which each was used and the reasons why it was considered the most suitable technique are discussed (7 Refs.).
Descriptors: OPTICAL DESIGN TECHNIQUES; LENSES; OPTICAL INSTRUMENT TESTING; HOLOGRAPHY; LIGHT INTERFEROMETRY
Identifiers: DESIGN; CONSTRUCTION; LARGE APERTURE OPTICAL SYSTEM; INTERFEROMETRIC TESTING TECHNIQUES; OPTICAL ELEMENTS; MOUNTING; MECHANICAL STABILITY; OPTICAL TESTS; MANGIN ELEMENTS; STAR TESTS; OTF; HOLOGRAPHIC TECHNIQUES; REFRACTING ELEMENTS; REFLECTING ELEMENTS; TEST PLATES; TWYMAN GREEN TECHNIQUE

HAINES, K.A. and HILDEBRAND, B.P.
"SURFACE DEFORMATION MEASUREMENT USING THE WAVEFRONT RECONSTRUCTION TECHNIQUE"
Appl. Opt., 5, 595 (1966)
No abstract provided.

HANDOJO, A. and DE JONG, J.
"INTERFEROMETER FOR OPTICAL TESTING WITH COMPUTER-GENERATED HOLOGRAMS"
Appl. Opt., 3, 546 (1977)
Describes a modified Twyman-Green Interferometer for use with computer generated holograms for optical testing. Discusses an application to examination of rotationally symmetric aspherical surfaces (11 Refs.).
Descriptors: OPTICAL TESTING; HOLOGRAPHIC INSTRUMENTS; LIGHT INTERFEROMETERS; ASPHERICAL LENSES
Identifiers: OPTICAL TESTING; COMPTER GENERATED HOLOGRAMS; ROTATIONALLY SYMMETRIC ASPHERICAL SURFACES; MODIFIED TWYMAN-GREEN INTERFEROMETER

HANSLER, R.L.
"APPLICATION OF HOLOGRAPHIC INTERFEROMETRY TO THE COMPARISON OF HIGHLY POLISHED REFLECTING SURFACES"
Appl. Opt., 7, 711 (1968)
No abstract provided.

HANSLER, R.L.
"A HOLOGRAPHIC FOUCAULT KNIFE-EDGE TEST FOR OPTICAL ELEMENTS OF ARBITRARY DESIGN"
Appl. Opt., 7, 1863 (1968)
No abstract provided.

HILDEBRAND, B.P., HAINES, K.A. and LARKIN, R.
"HOLOGRAPHY AS A TOOL IN THE TESTING OF LARGE APERTURES"
Appl. Opt., 6 1267 (1967)
No abstract provided.

HILDEBRAND, B.P. and HAINES, K.A.
"INTERFEROMETRIC MEASUREMENTS USING THE WAVEFRONT RECONSTRUCTION TECHNIQUES"
Appl. Opt., 5, 172 (1966)
No abstract provided.

HILDEBRAND, B.P.
"A HOLOGRAPHIC INSTRUMENT TO REPLACE THE TEST GLASS IN LENS TESTING"
Opt. Eng., 15, 24 (1976)
The objective was to produce an instrument giving similar results to the test glass, while preserving its simplicity. The research performed resulted in a very simple system wherein a single hologram contains a complete interferometer supplying both the illumination source and the reference. The instrument is designed to be used on lens surfaces without the need to remove them from the mandrel of the polishing machine. It is simply placed on the optical surface, contacting it at three points. Fringes similar to those obtained with a test glass are seen on a screen on the instrument. Each lens design requires a hologram specifically made to test its particular curvature. Since the holograms can be made cheaply and rapidly, considerable cost savings should result, since no precision test glasses need be made (6 Refs.).
Descriptors: HOLOGRAPHIC INTERFEROMETRY; OPTICAL TESTING; LENSES
Identifiers: HOLOGRAPHIC INSTRUMENT; LENS TESTING; INTERFEROMETER; COST SAVINGS; LENSES IN POLISHING MACHINE

HILDEBRAND, B.P., HAINES, K.A. and LARKIN, R.
"HOLOGRAPHY AS A TOOL IN THE TESTING OF LARGE APERTURES"
Appl. Opt. 6 1267 (1967)
No abstract provided.

KURTZ, R.L. and OWEN, R.B.
"HOLOGRAPHIC RECORDING MATERIALS - A REVIEW"
Opt. Eng., 14, 393 (1975)
No abstract provided.

LARIONOV, N.P., LUKIN, A.V., and MUSTAFIN, K.S.
"HOLOGRAPHIC INSPECTION OF SHAPES OF UNPOLISHED SURFACES"
Sov. J. Opt. Technol., 39, 154 (1972)
No abstract provided.

MAC GOVERN, A.J.
"PROJECTED FRINGES AND HOLOGRAPHY"
Appl. Opt., 11, 2972 (1972)
No abstract provided.

MALACARA, D.
"HOLOGRAPHIC LATERAL SHEAR INTERFEROMETER"
Appl. Opt., 11 2695 (1976)
Describes a new type of holographic lateral shear interferometer with some features similar to those of a holographic interferometer due to Wyant (4 Refs.).
Descriptors: HOLOGRAPHIC INTERFEROMETRY; OPTICAL TESTING; LIGHT INTERFEROMETERS
Identifiers: HOLOGRAPHIC LATERAL SHEAR INTERFEROMETER; TESTING; LENSES; ASPHERICAL SURFACES; SPHERICAL SURFACES

MALLICK, S. and ROBLIN, M.L.
"SHEARING INTERFEROMETRY BY WAVEFRONT RECONSTRUCTION USING A SINGLE EXPOSURE"
Appl.Phys. Lett., 14, 61 (1969)
No abstract provided.

MATSUMOTO, K.
"HOLOGRAPHIC MULTIPLE BEAM INTERFEROMETRY"
J. Opt. Soc. Am., 59, 777 (1969)
No abstract provided.

MOREAU, B.G. and HOPKINS, R.E.
"APPLICATION OF WAX TO FINE GROUND SURFACES TO SIMULATE POLISH"
Appl. Opt., 8, 2150 (1969)
No abstract provided.

MUNNERLYN, C.R. and LATTA, M.
"ROUGH SURFACE INTERFEROMETRY USING A CO_2 Laser Source"
Appl. Opt., 7, 1858 (1968)
No abstract provided.

PASTOR, J.
"HOLOGRAM INTERFEROMETRY AND OPTICAL TECHNOLOGY"
Appl. Opt., 8, 525 (1969)
No abstract provided.

PASTOR, J., EVANS, G.E. and HARRIS, J.S.
"HOLOGRAM-INTERFEROMETRY: A GEOMETRICAL APPROACH"
Opt. Acta, 17, 81 (1970)
No abstract provided.

RIBBENS, W.B.
"SURFACE ROUGHNESS MEASUREMENT BY HOLOGRAPHIC INTERFEROMETRY"
Appl. Opt., 11, 807 (1972)
This paper presents a method of measuring the roughness of a reflecting surface by studying the contrast ratio of a holographic interference pattern of this surface. A practical experimental configuration is illustrated along with the measurement results obtained for a set of lapped steel specimens. In addition, an approximate scalar theory is presented that correlates well with experiment.

ROGERS, G.L.
"THE EQUIVALENT INTERFEROMETER IN HOLOGRAPHY"
Opt. Acta, 17, 527 (1970)
No abstract provided.

SCHWIDER, J.
"ISOPHOTES AND ENHANCEMENT OF PHASE SENSITIVITY THROUGH OPTICAL FILTERING IN IMAGE HOLOGRAPHY"
Comptes Rendus du Symposium International: Applications d'Holographie, France, Juillet (1970)
No abstract provided.

SERGEYEV, P.A. and SINTSOV, V.N.
"TEST OF HOLOGRAPHIC METHOD OF MEASURING TWO-DIMENSIONAL TRANSFER FUNCTIONS OF OBJECTIVES"
Sov. J. Opt. Technol., 45, 280 (1978)
The design of an experiment, the method of recording hologram filters and the results of measurements of the two-dimensional modulation transfer functions of objectives with symmetrical and nonsymmetrical point spread functions are discussed. An optimum ratio of reference and object beam intensities is shown to exist at which the results of the measurements of the modulation transfer function agree with the calculated data

(3 Refs.).

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL VARIABLES MEASUREMENT; HOLOGRAPHY; LENSES; OPTICAL TESTING

Identifiers: HOLOGRAPHIC METHOD; HOLOGRAM FILTERS; OBJECTIVES; POINT SPREAD FUNCTIONS; MODULATION TRANFER FUNCTION; TWO DIMENSIONAL TRANSFER FUNCTIONS

SMITH, H.M.
PRINCIPLES OF HOLOGRAPHY
John Wiley, New York (1957)
No abstract provided.

SNOW, K. and VANDERWARKER, R.
"ON USING HOLOGRAMS FOR TEST GLASSES"
Appl. Opt., 9, 822 (1970)
No abstract provided.

TICHENOR, D.A. and MADSEN, V.P.
"COMPUTER ANALYSIS OF HOLOGRAPHIC INTEREROGRAMS FOR NONDESTRUCTIVE TESTING"
Opt. Eng., 18, 469 (1979)
We have developed an automated technique for interferogram interpretation using a *PDP-12 minicomputer, Cohu television camera* and Hughes scan converter. A digitized image of the interferogram is stored on disc, and a small area is read into central memory. The fringe density in that region is estimated based on the number of peaks found in several line scans across the area under study. This calculation is repeated for successive small areas until a map of fringe density covering the entire part is compiled. If the fringe density map falls within an acceptance profile, the part is accepted. Experimental results demonstrate that this technique works well on interferograms having substantial variations in intensity and fringe contrast.

TSURUTA, T. and ITOH, Y.
"HOLOGRAPHIC TWO BEAM INTERFEROMETRFY USING MULTIPLE REFLECTED LIGHT BEAMS"
Appl. Opt., 8, 2033 (1969)
No abstract provided.

VANDEELEN, W. and NISENSON, P.
"MIRROR BLANK TESTING BY REAL-TIME HOLOGRAPHIC INTERFEROMETRY"
Appl. Opt., 8, 951 (1969)
No abstract provided.

VIKRAM, C.S. and VEDAM, K.
"TESTING THE TRUENESS OF CIRCULAR SURFACES' A SIMPLE HOLOGRAPHIC METHOD"
Appl. Opt., 18, 627 (1979)
A new hologrphic method where the object motion or variation is transferred to some other subject (it can be called a probe) is suggested. The theory is developed and

verified experimentally for an ealing precision self-centering lens hlder as the probe. The method possesses many advantages over the conventional hologrphic interferometry, some of which are (1) the simultaneous presence of four discrete sensitivities to allow a measurable radius change from one to a few hundred wavelengths, (2) Comparison of different surfaces without the problem of decorrelation, and (3) no limitation on the light scattering or transmitting capability of the object under study. The limitations of the method are also discussed (3 Refs.).

Descriptors: HOLOGRAPHIC INTERFEROMETRY; OPTICAL TESTING
Identifiers: SIMPLE HOLOGRAPHIC METHOD; OBJECT MOTION; PROBE; TESTING; CIRCULAR SURFACE TRUENESS; EALING PRECISION SELF CENTERING LENS HOLDER; HOLOGRAPHIC INTERFEROMETRY

WYANT, J.C., O'NEILL, P.K. and MAC GOVERN, A.J.
"INTERFEROMETRIC METHOD OF MEASURING PLOTTER DISTORTION"
Appl. Opt., 13, 1549 (1974)

No abstract provided.

WYANT, J.C. and O'NEILL, P.K.
"COMPUTER GENERATED HOLOGRAM NULL LENS TEST OF ASPHERIC WAVEFRONTS"
Appl. Opt., 13, 2762 (1974)

To test an aspheric optical element, a second optical system (null lens or mirror) is often used to convert the aspheric wavefront into either a spherical or plane wavefront which is then compared interferometrically with a known wavefront. Accurate null optics for testing steep aspherics are expensive. Results for a test of the primary mirror of an eccentric Cassegrain system are described when combined with a relatively simple computer generated holograms (12 Refs.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; HOLOGRAPHY
Identifiers: COMPUTER GENERATED HOLOGRAM; NULL LENS TEST; ASPHERIC WAVEFRONTS; ECCENTRIC CASSEGRAIN SYSTEM; PRIMARY MIRROR

WYANT, J.C.
"CHAPTER 12. HOLOGRAPHIC AND MOIRE TECHNIQUES"
Optical Shop Testing, Malacara, D., Ed. (1978)

12.2 INTERFEROMETERS USING SYNTHETIC HOLOGRAMS

BIRCH, K.G. and GREEN, F.J.
"THE APPLICATION OF COMPUTER GENERATED HOLOGRAMS TO TESTING OPTICAL ELEMENTS"
J. Phys., 5, 1982 (1972)
No abstract provided.

MC GOVERN, A.J. and WYANT, J.C.
"COMPUTER GENERATED HOLOGRAMS FOR TESTING OPTICAL ELEMENTS"
Appl. Opt., 10, 619 (1971)
No abstract provided.

SCHMIDT, W., VOGEL, A., and PREUBLER, D.
"HOLOGRAPHIC CONTOUR MAPPING USING A DYE LASER"
Appl. Phys., 1, 103 (1973)
No abstract provided.

SIROHI, R.S.
"SYNTHETIC HOLOGRAPHY FOR OPTICAL TESTING"
J. Opt., 4, 79 (1975)
Computer generated holograms (CGHS) have been used for the testing of aspherical surfaces. The CGHS acts as a reference element in an interferometric configuration. The CGHS may be generated either by coding both amplitude and phase or by coding only the phase of the wavefront. It may be safely assumed that the wavefronts encountered during testing are of uniform amplitude and hence the methods using only phase coding for the generation of the hologram are of more relevance to testing. The procedure by Birch et al. (1972) for generating CGHS is modified. This modified procedure along with the concept of aberration balancing extends the capability of the CGHS: Even steep aspherics can be tested. The CGHS have been generated for the wavefront from a plano-convex lens both for its axial and off-axial positions (20 Refs.).
Descriptors: HOLOGRAPHY; OPTICAL TESTING; ABERRATIONS
Identifiers: ASPHERICAL SURFACES; INTERFEROMETRIC

CONFIGURATION; WAVEFRONTS; PHASE CODING; ABERRATION BALANCING; COMPUTER GENERATED HOLOGRAMS; PLANO CONVEX LENS; OPTICAL TESTING

SIROHI, R.S., BLUME, H., and ROSENBRUCH, K.J.
"OPTICAL TESTING USING SYNTHETIC HOLOGRAMS"
Opt. Acta, 23, 229 (1976)

A modification of the procedure of Birch and Green (1972) for computer generation of holograms is presented. The modified procedure is capable of generating holograms of more than 500 fringes with relative ease, thus making the testing of steep aspherics feasible without compensating optics. The ability of computer-generated holograms to evaluate aspherics was demonstrated by comparing the aspherical wavefront of a plano-convex lens at both on-axis and off-axis positions with the reconstructed wavefront of the hologram. The comparison indicated that the wave-aberration of the lens could be compensated by the hologram with an accuracy of +or- lamda/20 (17 Refs.).

Descriptors: HOLOGRAPHY; OPTICAL TESTING; PHYSICS APPLICATIONS OF COMPUTERS

Identifiers: SYNTHETIC HOLOGRAMS; COMPUTER GENERATION OF HOLOGRAMS; 500 FRINGES; STEEP ASPHERICS; OPTICAL TESTING; PLANOCONVEX LENS; WAVE ABERRATION COMPENSATION

TAKAHASHI, T., KONNO, T.K., and KAWAI, M.
"SOME IMPROVEMENTS IN COMPUTER HOLOGRAMS FOR TESTING ASPHERIC SURFACE"
Jap. J. Appl. Phys., 14, 247 (1975)

No abstract provided.

YATAGAI, T. and SAITO, H.
"INTERFEROMETRIC TESTING WITH COMPUTER-GENERATED HOLOGRAMS: ABERRATION BALANCING METHOD AND ERROR ANALYSIS"
Appl. Opt., 17, 558 (1978)

When testing aspheric surfaces with a computer-generated hologram, some problems should be considered. In this paper, first, we compare two types of hologram: Lohmann and interference. The phase error in the Lohmann type hologram is estimated and a method of compensating the error is described. Second, we discuss the relation between the shape of the required wavefront and the number of resolution cells of the hologram. Since testing smaller f number optical elements increases the required number of resolution cells of the hologram, we propose the aberration balancing method to reduce the number of resolution cells. The optimum values of the defocus aberration are calculated. Especially, it is shown that the number of resolution cells in the hologram is capable of being reduced to 25 misalignment of the optical system when the aberration balancing method is applied. Finally, an experimental example for testing an aspheric mirror 150mm in diameter and 300mm in focal length is given.

12.3 TWO-WAVELENGTH INTERFEROMETERS

HILDEBRAND, B.P. and HAINES, K.A.
"MULTIPLE WAVELENGTH AND MULTIPLE SOURCE HOLOGRAPHY APPLIED TO CONTOUR GENERATION"
J. Opt. Soc. Am., 57, 155 (1967)
No abstract provided.

JONES, R. and WYKES, C.
"THE COMPARISON OF COMPLEX OBJECT GEOMETRIES USING A COMBINATION OF ELECTRONIC SPECKLE PATTERN INTERFEROMETRIC DIFFERENCE CONTOURING AND HOLOGRAPHIC ILLUMINATION ELEMENTS"
Dept. Of Mechanical Engineering, Univ. of Technology, Loughborough, U.K. (1977)
This paper demonstrates that two-wavelenght speckle-pattern interferometry may be used to compare complex objects of nominally identical geometries. The principle of the technique is that the inspection object (usually of non-specular finish) is illuminated by a smooth master wavefront at wavelength lamda 1. The lamda 1 interferogram formed between the speckle image of this object and an in-line reference beam is then subtracted from the corresponding pattern observed at a second wavelength lamda 2. (Lamda2-lamda 1 is typically 10nm.) Speckle pattern correlation fringes observed in the subtracted pattern define differences between theinspection object and master wavefront of magnitude G lamda 1 lamda 2/(lamda 2-lamda 1), where G is a function of the object geometry. Master wavefronts of complex geometry are reconstructed by holographic elements which initially record the light field reflected from a specular master component. This field is reconstructed to form the required illumination wavefront by re-illuminating the hologram with a wavefront of identical geometry to the recording reference wavefront but propagating in the opposite direction. Theoretical and practical aspects of the work are discussed and a summary of experimental results is presented.

PILSTON, R.G. and STEINBERG, G.N.
"MULTIPLE-WAVELENGTH INTERFEROMETRY WITH TUNABLE SOURCE"
Appl. Opt., 8, 5553 (1969)
In an Optical Materials Study Program, which was undertaken by the Perkin-Elmer Corporation, it was of interest to determine how material dimensional instabilities affect optically flat surfaces. The obvious noncontacting mehtod for sensing changes in flatness of an optical surface is the multiple-beam Fizeau interferometer. The usual Fizeau interferometer is illuminated by a signle wavelenght source, and, therefore, is limited in its detection of small surface figure changes to an interpolation of a lamda/2 fringe spacing. By use of a multiple wavelength source of sources, the information content of an interferogram can be substantially increased by producing additional reference fringes in the intervals between the usual lamda/2 fringes, thereby improving the ability to interpolate small changes in figure.

In the interferometer described here, multiple wavelengths are produced in sequence by a tunable, single mode laser. With the parameters of the tunable laser and interferometer cavity which ave been chosen, the fringe separation is lamda/17. The limit of detectable surface errors is less than 0.0035 lamda.

POLHEMUS, C.
"TWO-WAVELENGTH INTERFEROMETRY"
Appl. Opt., 12, 2071 (1973)
No abstract provided.

SWANTNER, W. and HAYSLETT, C.R.
"MULTI-WAVELENGTH INTERFEROMETRIC TESTING"
U.S. Army White Sands Missile Range, New Mexico 88002
We have built a modified Twyman-Green interferometer illuminated with a krypton laser. The configuration allows for center of curvature or autocollimation testing at various selected wavelengths. Software data reduction uses a Zernike polynomial fit to the wavefront. The interferograms are all made without moving the source, so the effects of axial color, lateral color, and chromatic variation of aberrations will exhibit themselves in a straightforward fashion in terms of the coefficients of the Zernike polynomials. Also, a scheme for using this information in the calculation of a polychromatic optical transfer function (OTF) has been developed. Requirements for the interferometer's optics are examined, and interferometer calibration discussed.

WYANT, J.C.
"TESTING ASPHERICS USING TWO WAVELENGTH HOLOGRAPHY"
Appl. Opt., 10, 2113 (1971)
It is shown that both single exposure and double exposure two-wavelength holography provide a good method of using visible light to obtain an interferogram identical to what would be obtained if a long nonvisible wavelength were used. Both techniques provide for the real-time adjustment of defocus and tilt in the final interferogram. When both hologram exposures are made simultaneously, the sensitivity to air turbulence is essentially the same as if the long nonvisible wavelength were used. Results are shown for testing both lenses and mirrors at equivalent wavelengths at 6.45 mu, 9.47 mu, 14.20 mu, 20.22 mu, and 28.50 mu obtained by using an argon laser for the visible light source.

WYANT, J.C.
"TWO-WAVELENGTH HOLOGRAPHY"
Itek Technical Report 8207.15 (1972)
No abstract provided.

ZELENKA, J.S. and VARNER, J.R.
"A NEW METHOD FOR GENERATING DEPTH CONTOURS HOLOGRAPHICALLY"
Appl. Opt., 7, 2107 (1968)
No abstract provided.

ZELENKA, J.S. and VARNER, J.R.
"MULTIPLE-INDEX HOLOGRAPHIC CONTOURING"
Appl. Opt., 8, 1431 (1969)
No abstract provided.

12.4 USE OF MOIRE FRINGES

ARCHBOLD, E. and ENNOS, A.E.
"DISPACEMENT MEASUREMENT FROM DOUBLE EXPOSURE LASER PHOTOGRAPHS"
Opt. Acta, 19, 253 (1972)
No abstract provided.

BENTON, S.A. and MERRILL, D.P.
"SIMPLIFIED TALBOT INTERFEROMETERS FOR LENS TESTING"
Opt. Eng., 15, 328 (1976)
Moire fringes and the Talbot self-imaging effect can be combined to produce shearing-interferometric-like maps of lens refractive power with high sensitivity and accuracy. The properties of a simplified interferometer, consisting of a white-light source and two dissimilar gratings, designed to be rugged enough for field testing of sunglasses lenses, are explored (15 Refs.).
Descriptors: LENSES; OPTICAL TESTING; INTERFEROMETERS; LIGHT REFRACTION; VISION
Identifiers: TALBOT INTERFEROMETERS; MOIRE FRINGES; LENS REFRACTIVE POWER; SENSITIVITY; ACCURACY; DISSIMILAR GRATINGS; FIELD TESTING OF SUNGLASS LENSES; TALBOT SELF IMAGING EFFECT; SHEARING INTERFEROMETER LIKE MAPS; WHITE LIGHT SOURCE

BRDICKO, J., OLSON, M.D., and HAZELL, C.R.
"THEORY FOR SURFACE DISPLACEMENT AND STRAIN MEASUREMENTS BY LASER SPECKLE INTERFEROMETRY"
Opt. Acta, 25, 963 (1978)
No abstract provided.

BROOKS, R.E. and HEFLINGER, L.O.
"MOIRE GAUGING USING OPTICAL INTERFERENCE PATTERNS"
Appl. Opt., 8, 935 (1969)
No abstract provided.

BRYNGDAHL, O.
"POLARIZATION-TYPE INTERFERENCE-FRINGE SHIFTER"
J. Opt. Soc. Am., 62, 462 (1972)
No abstract provided.

CHIANG, F.P.
"A METHOD TO INCREASE THE ACCURACY OF MOIRE MTHOD"
J. Engrg. Mech. Div. Proc. ASCE, 91, 137 (1965)
No abstract provided.

CHIANG, F.P., PARKS, V.J., and DURELLI, A.J.
"MOIRE FRINGE INTERPOLATION AND MULTIPLICATION BY FRINGE SHIFTING"
Experimental Mechanics, 8, 554 (1968)
No abstract provided.

CHIANG, F.P.
"TECHNIQUES OF OPTICAL SPATIAL FILTERING APPLIED TO THE PROCESSING OF MOIRE FRINGES"
Experimental Mechanics, 6, 523 (1969)
No abstract provided.

CHIANG, F.P.
"DETERMINATION OF SIGNS IN THE MOIRE METHOD"
J. Engineering Mechanics Divisaion Proc. ASE, 95, 1379 (1969)
No abstract provided.

CHIANG, F.P.
"ON MOIRE METHOD APPLIED TO THE DETERMINATION OF TWO-DIMENSIONAL DYNAMIC STRAIN DISTRIBUTIONS"
J. Appl. Mech. Trans. ASME, 39, 829 (1972)
No abstract provided.

CHIANG, F.P., OPLINGER, D.W., PARKER, B.S. and SLEPTZ, J.
"STRAIN ANALYSIS OF COMPOSITES BY MOIRE METHODS"
Experimental Mechanics, 14, 206 (1974)
No abstract provided.

CHIANG, F.P.
"PROC. CONFERENCE ON SPECKLE PHENOMENA AND THEIR APPLICATIONS"
Loghborough University (1974)
No abstract provided.

CHIANG, F.P.,
"SHIFTING OF FRINGES IN MOIRE METHODS"
Progress in Experimental Mechanics 99 (1975)
No abstract provided.

CHIANG, F.P.
"A NEW THREE-DIMENSIONAL STRAIN ANALYSIS TECHNIQUE BY SCATTERED LIGHT SPECKLE INTERFEROMETRY"
The Engineering Uses of Coherent Optics 249 (1976)
No abstract provided.

CHIANG, F.P. and JUANG, R.M.
"VIBRATION ANALYSIS OF PLATES AND SHELLS BY LASER SPECKLE INTERFEROMETRY"
Opt. Acta, 23 997 (1976)
No abstract provided.

CHIANG, F.P., and JUANG, R.M.
"LASER SPECKLE INTERFEROMETRY FOR PLATE BENDING PROBLEMS"
Appl. Opt., 15, 2199 (1976)
No abstract provided.

CHIANG, F.P. and LEE, C.H.
"DYNAMIC LASER SPECKLE INTERFEROMETRY APPLIED TO TRANSIENT FLEXURE PROBLEMS"
Appl. Opt., 16, 2199 (1977)
No abstract provided.

CHIANG, F.P. and KHETAN, R.P.
"STRAIN ANALYSIS BY ONE-BEAM LASER SPECKLE INTERFEROMETRY, PART II, MULTIAPERTURE METHOD"
SUNY at Stoney Brook College of Engrg. and Appl. Sci. Rept No. 253 (1978)
No abstract provided.

CHIANG, F.P.
"A NEW FAMILY OF 2D AND 3D EXPERIMENTAL STRESS ANLYSIS TECHNIQUES USING LASER SPECKLES"
Solid Mechanics Archives, 3, 1 (1978)
No abstract provided.

CHIANG, F.P.
"DYNAMIC LASER SPECKLE INTERFEROMETRY APPLIED TO WAVE PROPAGATION IN SOLIDS"
Proc. 13th Int. Cong. of High Speed Photography and Photonics - Tokyo (1978)
No abstract provided.

CHIANG, F.P. and KAO, T.Y.
"MAPPING IN-PLANE STRESS WAVES IN SOLIDS BY LASER SPECKLES"
Mechanics Research Communications, 5, 133 (1978)
No abstract provided.

CHIANG, F.P.
"MOIRE METHODS OF STRAIN ANALYSIS"
Manual on Experimental Stress Analysis (1978)
No abstract provided.

CHIANG, F.P.
"MOIRE METHODS FOR CONTOURING DISPACEMENT, DEFLECTGION, SLOPE AND CURVATURE"
Advances in Optical Metrology, SPIE, 153 (1978)
No abstract provided.

CHIANG, F.P. and JAISINGH, G.
"ON THE INFLUENCE OF STRAIN IN ONE-BEAM LASER SPECKLE INTERFEROMETRY"
Spring Meeting of the SESA (1979)
No abstract provided.

CHIANG, F.P.
"OPTICAL STRESS ANALYSIS USING MOIRE FRINGE AND LASER SPECKLES"
Opt. Eng., 18, 448 (1979)
The paper reviews a series of experimental stress analysis methods using moire fringe and laser speckles. An analogy is drawn between the two groups of methods showing that moire methods are special cases of speckle methods. Difference between the two approaches are also pointed out. The experimental methods discussed include the anlysis of plane stress and general three-dimensional problems, static and dynamic bending of plates, steady state vibration and transient stress problems.

CHIANG, F.P., PARKER, B., OPLINGER, D., and SLEPETZ, J.
"MULTIPURPOSE OPTICAL MOIRE PROCESSOR"
Opt. Eng., 18 (1979)
A multipurpose optical moire processor is described whereby one can introduce mismatches fringes, perform fringe multiplication and shifting,and separate u- and v-field isothetics. These functions can be done individually, sequentially, or simultaneously.

CHIANG, F.P. and LIN, C.J.
"A TIME AVERAGE REFLECTION MOIRE METHOD FOR VIBRATION ANALYSIS OF PLATES"
Appl. Opt., 18, 1424 (1979)
No abstract provided.

DANIEL, I.M., ROWLANDS, R.E., and POST, D.
"STRAIN ANALYSIS OF COMPOSITES BY MOIRE METHODS"
Experimental Mechanics, 13, 246 (1973)
No abstract provided.

DESSUS, B. and LE BLANC, M.
"THE FRINGE METHOD AND ITS APPLICATION TO THE MEASUREMENT OF DEFORMATIONS, VIBRATIONS, CONTOUR LINES AND DIFFERENCES OF OBJECTS"
Etudes et Recherches, Division Mesure, Electricite de France (1973)
A variable sensitivity technique using the projection of a fringe pattern is demonstrated for mapping deformations, vibrations, contour lines and differences between two objects. The method does not require laser illumination and gives an opportunity for studying large objects with incoherent light, and is compared with other techniques such as holography or speckle. The limitations likely to be encountered in industrial environments are discussed. The realization and incoherent project of gratings is also discussed.

DUFFY, D.E.
"MOIRE GAGE OF IN-PLANE DISPLACEMENT USING DOUBLE APERTURE IMAGING"
Appl. Opt., 11, 1787 (1972)
No abstract provided.

FOUERE, J.C. and MALACARA, D.
"FOCUSING ERRORS IN A COLLIMATING LENS OR MIRROR USE OF A MOIRE TECHNIQUE"
Appl. Opt., 13, 1322 (1974)
The Fresnel diffraction pattern of a grating illuminated with parallel coherent light produces an exact image of the grating. By viewing the Fresnel image of the first grated through a second grating, moire patterns are observed which may be used to study the focusing errors in a collimating lens or a mirror. Theory and experimental verification are given (13 Refs)

Descriptors: LIGHT INTERFERENCE; FOCUSING; OPTICAL TESTING; LENSES; MIRRORS; LIGHT DIFFRACTION; DIFFRACTION GRATINGS

Identifiers: COLLIMATING LENS; MIRROR; MOIRE TECHNIQUE; FRESNEL DIFFRACTION PATTERN; GRATING; PARALLEL COHERENNT LIGHT; FOCUSING ERRORS

GRUMET, A.
"A MOIRE TECHNIQUE FOR RAPID ALIGNMENT, FOCUS, AND SCALING OF IMAGERY"
Opt. Eng., 15, 460 (1976)
A rapid procedure is outlined that permits accurate alignment, focus, and scaling of imagery at two separated locations in an optical system. The moire pattern formed by pairs of identical gratings permits the full image pupil to be observed and adjusted. Alignment and scaling can be adjusted to an accuracy of the order of the gratings's fundamental spacing.

HUNG, Y.Y., HU, C.P. and TAYLOR, C.E.
"SPECKLE-MOIRE INTERFEROMETRY: A TOOL FOR COMPLETE MEASUREMENT OF IN-PLANE SURFACE DISPLACEMENT"
Proc. 7th Sourtheastern Conference on Theoretical and Applied Mechanics, 497 (1974)

No abstract provided.

JONES, O.C. and FORNO, C.
"HIGH FREQUENCY MOIRE FRINGE INTERPOLATION USING ELECTRO-OPTIC CRYSTALS"
Opt. Eng., 14, 259 (1975)

A novel and promising technique for moire fringe interpolation using an electro-optic polarization rotator is described and the results of an initial feasibility study are presented. The possibility of very high- frequency operation using electro-optic crystals should permit high accuracy prositional measurements on mechanical components moving with appreciable velocities. Resolution of displacement of 0.1 mum was achieved with the best system. The main disadvantage of the electro-optic system is the sensitivity to temperature changes and mechanical misalignment.

JONES, R. and WYKES, C.
"THE COMPARISON OF COMPLEX OBJECT GEOMETRIES USING A COMBINATION OF ELECTRONIC SPECKLE PATERN INTERFEROMETRIC DIFFERENCE CONTOURING AND HOLOGRAPHIC ILLUMINATION ELEMENTS"
Dept. of Mech. Engrg, University of Technol. Loughborough, U.K. (1977)

This paper demonstrates that two-wavelength speckle-pattern interferometry may be used to compare complex objects of nominally identical geometries. The principle of the technique is that the inspection object (usually of non-specular finish) is illuminated by a smooth"master wavefront" at wavelength lamda 1. The lamda 1 interferogram formed between the speckle image of this object and an in-line reference beam is then subtracted from the corresponding pattern observed at a second wavelength lamda 2. (lamda 2 - lamda 1 is typically 10 nm.) Speckle pattern correlaton fringes observed in the subtracted pattern define differences between the inspection object and master wavefront of magnitude G lamda 1 lamda 2(lamda 2 - lamda 1), where G is a function of the object geometry. Master wavefronts of complex geometry are reconstructed by holographic elements which initially record the light field reflected from a specular master component. This field is reconstructed to form the required illuminaton wavefront by re- illuminating the hologram with a wavefront of identical geometry to the recording reference wavefront but propagating in the opposite directon. Theoretical and practical aspects of the work are discussed and a summary of experimental results is presented.

KHETAN, R.P. and CHIANG, F.P.
"STRAINS ANALYSIS BY ONE-BEAM LASER SPECKLE INTERFEROMETRY I: SINGLE APERTURE METHOD"
Appl. Opt., 15, 2205 (1976)

No abstract provided.

LANGENBECK, P.
"OPTICAL: WAVE-FRONT MAPPING BY DUAL INTERFEROMETRY"
J. Opt. Soc. Am., 58, 499 (1968)
No abstract provided.

LAU, E.
"DIE DUPLIGRAMM-METHODE ZUR AUSWETUNG VON INTERFEROGRAMMEN"
(THE DUPLIGRAM METHOD FOR EVALUATING INTERFEROGRAMS)
Optik (Stuttg.) 12, 23 (1955)
No abstract provided.

LOOMIS, J.S.
"FRINGE USER'S MANUAL, VERSION 2"
Optical Sciences Center, Univ. of Arizona (1976)
No abstract provided.

OPLINGER, D.W., PARKER, B.S., and KATZ, A.
"MOIRE MEASUREMENT OF STRAINS AND DEFORMATONS IN PIN-LOADED COMPOSITE PLATES"
Soc. of Exp. Stress Analysis Annual Spring Meeting (1978)
No abstract provided.

PARKER, R.J.
"SURFACE TOPOGRAPHY OF NON-OPTICAL SURFACES BY OBLIQUE PROJECTION OF FRINGES FROM DIFFRACTION RATINGS"
Blackett Laboratory, Imperial College, England (1978)
A very simple method for examining surface topography is described. It employs a single collimated beam and a diffracton rating. The sensitivity can be varied from a few millimeters to a few microns by selection of the appropriate grating. The angular parameters governing the system are defined and their effect on the sensitivity verified experimentally. The use of the system for detaled meterology and rapid surface form visualizaton are described.

PETERS, W.N. and IVALDI, J.
"MOIRE PHASE-MEASURING INTERFEROMETER FOR ASPHERIC MIRRORS"
J. Opt. Soc. Am., 61, 655 (1971)
No abstract provided.

POST, D.
"MOIRE GRID-ANALYZER METHOD FOR STRESS ANALYSIS"
Experimental Mechanics, 8, 3 (1968)
No abstract provided.

POST, D.
"NEW OPTICAL METHODS OF MOIRE FRINGE MULTIPLICATON"
Experimental Mechanics, 8, 63 (1968)
No abstract provided.

RILEY, W.F. and DURELLI, A.J.
"APPLICATON OF MOIRE METHODS TO THE DETERMINATON OF TRANSIENT STRESS AND STRAIN DISTRIBUTIONS"
J. Appl. Mech., 29, 23 (1962)
No abstract provided.

ROGERS, G.L. and ROGERS, L.C.G.
"THE INTERRELATONS BETWEEN MOIRE PATTERNS, CONTOUR FRINGES, OPTICAL SURFACES AND THEIR SUM AND DIFFERENCE EFFECTS"
Dept. of Physics, Univ. of Aston. England (1976)
A general relationship between potential functions and moire patterns can be realized in a number of forms. The potential function can be worked as an optical surface and combined with other potential functions similarly worked to give the solution to a complex potential problem. Contour fringes can be produced from the optical surfaces or generated on a computer graph plotter directly. When superimposed these contour lines generate moire fringes which are also solutions to potential function problems but with an essential ambiguity of sign. Two circularly symmetrical potential wells have been contoured and moire fringe solutions to simple problems are given.

SCIAMMARELLA, C.A. and LUROWIST, N.
"MULTIPLICATION AND INTERPOLATON OF MOIRE FRINGE ORDER BY PURELY OPTICAL TECHNIQUES"
J. Appl. Mech., 32, 425 (1967)
No abstract provided.

TASAKI, H.
"MOIRE TOPOGRAPHY"
Appl. Opt., 9, 1467 (1970)
No abstract provided.

TASAKI, H.
A"MOIRE TOPOGRAPHY"
Appl. Opt., 12, 845 (1973)
No abstract provided.

WALKER, C.A. and MCKELVIE, J.
"A PRACTICAL MULTIPLIED MOIRE SYSTEM"
Expermental Mechanics, 18, 316 (1978)
No abstract provided.

WILLIAMS, T.L.
"AN INSTRUMENT FOR MEASURING THE MTF OF LENSES USED IN THERMAL IMAGING AND OTHER INFRARED SYSTEMS (2 to 14 mum)"
Soc. Photo-Optical Instrumentaton Engrgs. (1974)

An instrument is described which can be used for measuring directly the MTF of infrared optical systems operating in the wavelength range 2 to 14 mum. The instrument uses a moire fringe technique for generating the test target, but a novel arrangement permits measurements at single spatial frequencies as well as over a continuous range of frequencies. The instrment is designed to give automatic normalization and has facilities enabling the line spread functon to be measured directly (19 Refs.).

Descriptors: OPTICAL INSTRUMENT TESTING; LENSES; INFRARED IMAGING; OPTICAL IMAGES; TRANSFER FUNCTONS

Identifiers: LENSES; THERMAL IMAGING; INFRARED SYSTEMS; INFRARED OPTICAL SYSTEMS; MOIRE FRINGE TECHNIQUE; LINE SPREAD FUNCTION; AUTOMATIC NORMALIZATION

YOKOZEKI, S. and SUZUKI, T.
"SHEARING INTERFEROMETER USING THE GRATNG AS THE BEAM SPLITTER"
Appl. Opt., 10, 1575 (1975)

The theoretical interpretation of the shearing interferometer based on the moire method using the fourier image of the grating is described. To obtain a pattern with good contrast, the observing plane must coincide with the normal fourier image plane of the grating or with the reversed fourier image plane. The information obtained by this method is the first partial derivative and under certain conditions the second partial derivative of the distortion from the reference wavefront, which is planar or spherical. Applications to measurement of the phase gradient and lens aberrations are shown.

YOKOZEKI, S. and OHNISHI, K.
"SPHERICAL ABERRATON MEASUREMENT WITH SHEARNG INTERFERMETER USING FOURIER IMAGING AND MOIRE METHOD"
Appl. Opt., 14, 623 (1975)

In this shearing interferometer, a collimated monochromatic beam illuminates a rating to produce good contrast interference fringes periodically at distance ND/SUP 2//Lamda from the grating. The fringes are of the same spacing (D) as the grating and constitute a fourier image of the grating. If a phase object is placed between the grating and its fourier image, the fourier image is distorted. A second grating (master grating) is superimposed on the distorted fourier image to produce a moire pattern. The informaton obtained is the partial derivative of the departure from the reference wavefront caused by the phase object. In an arrangement using a spherical reference wavefront (see Abst. A57178 of 1971) to measure the lateral spherical aberration of a camera lens with small F-number (1.7), it is shown that it is necessary to correct for distortion of the observed fringes. An arrangement usng a plane reference wavefront is described and this gives the lateral spherical aberration directly from the moire pattern. Theory is given for both arrangements (6 Refs.).

Descriptors: LIGHT INTERFEROMETRY; OPTICAL VARIABLES

MEASUREMENT; ABERRATIONS; OPTICAL TESTING

Identifiers: COLLIMATED MONOCHROMATIC BEAM; FRINGE DISTORTION CORRECTION; SPHERICAL ABERRATION MEASUREMENT; SHEARING INTERFEROMETER; FOURIER IMAGING; MOIRE METHOD; PHASE OBJECT; CAMERA LENS

13 NULL TESTS USING COMPENSATORS

13.1 DALL-KIRKHAM AND OFFNER COMPENSATORS

BROWN, E.B.
"AN EXPERIENCE WITH THE DALL NULL TEST"
Sky Telesc., 14, 512 (1954)
No abstract provided.

COUDER, A.
"USES OF A TWO-LENS COMPENSATOR"
Rev. Opt. Theor. Instrum., 6, 2 (1927)
No abstract provided.

DALL, H.E.
"A NULL TEST FOR PARABOLOIDS"
J. Br. Astron. Assoc., 57, 201 (1947)
No abstract provided.

HOLLERAN, R.T.
"AN ALGEBRAIC SOLUTION FOR THE SMALL LENS NULL COMPENSATOR"
Appl. Opt., 7, 137 (1968)
No abstract provided.

LYTLE, J.D.
"PROBLEMS IN NULL CORRECTOR DESIGN"
Opt. Sci. Center Tech. Rept. 39 (1969)
No abstract provided.

LYTLE, J.D.
"A SUGGESTED PROCEDURE FOR TESTING LARGE CASSEGRAINIAN OPTICAL SYSTEMS"
Appl. Opt., 9, 2497 (1970)
No abstract provided.

OFFNER, A.
"A NULL CORRECTOR FOR PARABOLOIDAL MIRRORS"
Appl. Opt., 2, 153 (1963)
No abstract provided.

OFFNER, A.
"FIELD LENSES AND SECONDARY AXIAL ABERRATION"
Appl. Opt., 8, 1735 (1969)
No abstract provided.

OFFNER, A.
"CHAPTER 14. NULL TEST USING COMPENSATORS"
Optical Shop Testing, Malacara, D., Ed. (1978)
14.1 Historical Background
14.2 The Dall Compensator
14.3 The Offner Compensator
14.3.1 Refractive Offner Compensator
14.3.2 Reflective Offner Compensator
14.4 Other Null Tests for Concave Conicoids
14.5 Hindle Type Tests

PURYAYEV, D.T.
"COMPENSATOR FOR INSPECTING THE QUALITY OF LARGE-DIAMETER PARABOLIC MIRRORS"
Sov. J. Opt. Technol., 40, 238 (1973)
No abstract provided.

SCHLAUCH, J.
"CONSTRUCTON OF A DALL NULL TESTER"
Sky Telesc., 19, 222 (1959)
No abstract provided.

SCIAMMARELLA, C.A. and CHIANG, F.P.
"MOIRE METHOD APPLIED TO THREEDIMENSIONAL ELASTIC PROBLEMS"
Experimental Mechanics, 4, 313 (1964)
No abstract provided.

SIMON, M.C. and SIMON, J.M.
"TESTING OF FLAT OPTICAL SURFACES BY THE QUANTITATIVE FOUCAULT METHOD"
Appl. Opt., 17, 132 (1978)
The complete theory of measurement of optical flat mirrors of circular or elliptical shape using the quantitative Foucault method is described here. It has been used in Cordoba since 1939 in a partial intuitive but correct form. The surface, not yet flat and, at times, astigmatic, is assimilated to the sum of a spherical plus a cylindrical dome. The errors of the three possible ways of reckoning are calculated.

STOLTZMANN, D.E. and HATCH, M.
"EXTENSIONS OF THE DALL NULL TEST"
Sky Telesc., 52, 210 (1976).
No abstract provided.

WILSON, R.N.
"CORRECTOR SYSTEMS FOR CASSEGRAN TELESCOPES"
Appl. Opt., 7, 253 (1968)
No abstract provided.

YODER, P.R., PATRICK, F.B. and GEE, A.E.
"APPLICATION OF THE RAYLEIGH CRITERION TO THE NULL TEST OF DALL-KIRKHAM PRIMARY MIRRORS"
J. Opt. Soc. Am., 45, 881 (1955)
No abstract provided.

13.2 OTHER NULL COMPENSATORS

BURCH, C.R.
"ON REFLECTION COMPENSATORS FOR TESTING PARABOLOIDS"
Mon. Not. R. Astron. Soc., 96, 438 (1936)
No abstract provided.

BURCH, C.R.
"REPORT OF THE GENERAL MEETING OF THE ASSOCIATION"
J. B. Astron. Assoc., 48, 99 (1938)
No abstract provided.

BURCH, C.R.
"TOLERANCES PERMISSIBLE IN FLATS FOR AUTOCOLLIMATION TESTS"
Mon. Not. R. Astron. Soc., 98, 670 (1938)
No abstract provided.

COUDER, A.
"PROCEDE D'UN MIROIR CONCAVE NON-SPHERIQUE"
Rev. Opt. Theor. Instrum., 6, 49 (1927)
No abstract provided.

DALL, H.E.
"A NULL TEST FOR PARABOLOIDS"
Amateur Telescope Making, 3, 149 (1953)
No abstract provided.

DODGEN, D.
"LARGE-APERTURE GROUND-BASED TELESCOPE DESIGN AND FABRICATION"
Opt. Eng., 14, 520 (1975)

The optical fabrication and testing of the optical components for two large optical telescopes is described. These systems are the 88-inch aperture telescope for the University of Hawaii and the 85-inch telescope for the Universidad de La Plata. A brief historical account of events to the large optic facility is included.

EVERHART, E.
"NULL TEST FOR WRIGHT TELESCOPE MIRRORS"
Appl. Opt., 5, 717 (1966)

The Wright telescope is a variation of the Schmidt design which uses a corrector plate at the focus and whose primary mirror is an oblate spheroid. A null test for the mirror is described which is a modification of the Foucault test, and which makes use of the properties of a particular reference ellipse.

FAULDE, M., FERCHER, A.F., TORGE, R., and WILSON, R.N.
"OPTICAL TESTING BY MEANS OF SYNTHETIC HOLOGRAMS AND PARTIAL LENS COMPENSATION"
Opt. Commuun., 7, 363 (1973)

The aberration of the most important aspheric surfaces at their centers of curvature is mainly third order. Partial compensation for the aberration by a singlet lens can considerably extend the limits of the application of the holographic test method (5 Refs.).

Descriptors: OPTICAL TESTING; HOLOGRAPHY; ABERRATIONS; ASPHERICAL LENSES

Identifiers: OPTICAL TESTING; SYNTHETIC HOLOGRAMS; PARTIAL LENS COMPENSATION; ABERRATION; ASPHERIC SURFACES; CENTRES OF CURVATURE

FISCHER, R.
"NULL-LENS MAPPING ERRORS"
J. Opt. Soc. Am., 61, 655 (1971)

No abstract provided.

FOUCAULT, L.
"MEMOIRE SUR LA CONSTRUCTION DES TELESCOPES EN VERRE ARGENTE"
(ON THE CONSTRUCTION OF TELESCOPES IN SILVERED GLASS)
Annal. Obs., 5, 197 (1859)

No abstract provided.

GASCOIGNE, S.C.B.
"A NULL TEST FOR CONCAVE MIRRORS"
Mon. Not. R. Astron. Soc., 100, 462 (1940)

No abstract provided.

HEINTZE, L.R., POLSTER, H.D. and VRABEL, J.
"A MULTIPLE-BEAM INTERFEROMETER FOR USE WITH SPHERICAL WAVEFRONTS"
Appl. Opt., 6, 1924 (1967)
No abstract provided.

HILBERT, R.S. and RIMMER, M.P.
"A VARIABLE REFRACTIVE NULL LENS"
(1970)
Null lenses, for use with rotationally symmetric but nonspherical surface re extremely useful for testing during producton. In general, each different system to be tested requires a different null lens. A variable null lens is proposed with consists of two aspheric plates, each of which introduces approxmately fourth- or sixth-order spherical aberration. When the plates are inserted in a diverging beam, the effect on the wavefront may be changed by varying the plate spacing. The system may be used to test parabols and other nonspherical mirrors at center of curvature, aspheric plates in conjunction with spherical mirrors, and various other systems. Once the two plates have been produced and measured, the spacing of the plates used may be determined for each test. This would normally be done by computer, using any of the optimizaton techniques for lens design. Examples are shown, and an estimate of obtainable survey is given.

HINDLE, J.H.
"A NEW TEST FOR CASSEGRAINIAN AND GREGORIAN SECONDARY MIRRORS"
Mon. Not. R. Astron. Soc., 91, 592 (1931)
No abstract provided.

HOLLERAN, R.T.
"IMMERSON NULL TEST FOR ASPHERICS"
Appl. Opt., 2, 1336 (1963)
No abstract provided.

HOLLERAN, R.T.
"NULL TESTING TELESCOPE MIRRORS BY IMMERSION"
Sky Telesc., 28, 242 (1964)
No abstract provided.

HOLLERAN, R.T.
"THIRD ORDER WAVEFRONTS AND RELATED NULL TESTS"
Appl. Opt., 5, 1244 (1966)
No abstract provided.

HOOKER, R.B.
"AUTOMATIC WAVEFRONT ERROR SENSOR"
(1973)
The automatic wavefront error sensor has been developed for determining the wavefront

error of an optical system. The instrument, which provides a null test for a parabola, measures the ray intercept error and automatically converts this to a wavefront error. Both the ray fan plot and the wavefront error curve are plotted simultaneously. Ray intercept errors smaller than 0.1 mum can be measured, providing wavefront error information with interferometric sensitivity.

HOPKINS, G.W. and SHAGAM, R.N.
"NULL RONCHI GRATINGS FROM SPOT DIAGRAMS"
Appl. Opt., 16, 2602 (1977)
Null Ronchi gratings have been discussed and constructed by Mobsby and by Malacara and Cornejo, who describe a scheme for calculating the position of rulings. Pastor has also devised a "reversed self-adaptive Ronchi test".

HOUSTON, J.B., Jr., BUCCINI, C.J. and O'NEILL, P.K.
"A LASER UNEQUAL PATH INTERFEROMETER FOR THE OPTICAL SHOP"
Appl. Opt., 6, 1237 (1967)
No abstract provided.

JAMES, W.E. and WATERWORTH, M.D.
"A METHOB FOR TESTING ASPHERIC SURFACES"
Opt. Acta, 12, 223 (1965)
No abstract provided.

MALACARA, D. and CORNEJO, A.
"NULL RONCHI TEST FOR ASPHERICAL SURFACES"
Appl. Opt. 13, 1778 (1974)
Proposes a Ronchi ruling with calculated curved lines the curvature of which compensates for asphericity of the test surface and thereby produces straight fringes of constant thickness which are more easily matched during the figuring process than the fringes of the normal Ronchi test. A monochromatic point source (laser) is necessary for the proposed test. Results for a paraboloidal mirror are given (3 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; LIGHT DIFFRACTION; DIFFRACTION GRATINGS; ASPHERICAL LENSES; MIRRORS
Identifiers: NULL RONCHI TEST; ASPHERICAL SURFACES; FIGURING PROCESS; MONOCHROMATIC POINT SOURCE; PARABOLOIDAL MIRROR; OPTICAL TESTING

NORMAN, B.A.
"NEW TEST FOR CASSEGRAINIAN SECONDARIES"
Sky Telesc., 17, 38 (1957)
No abstract provided.

PURYAYEV, D.T.
"ALIGNMENT OF AUTOCOLLIMATING SYSTEMS USED FOR QUALITY CONTROL OF SECOND-ORDER ASPHERICAL SURFACES OF REVOLUTION"
Sov. J. Opt. Technol., 35, 355 (1968)
No abstract provided.

PURYAYEV, D.T.
"QUALITY CONTROL OF ASPHERICAL SURFACES BY AN INTERFEROMETRIC COMPENSATING METHOD"
Sov. J. Opt. Technol., 35, 624 (1968)
No abstract provided.

PURYAYEV, D.T.
"A QUALITY CONTROL TECHNIQUE FOR CONVEX ELLIPTICAL, PARABOLIC AND HYPERBOLIC SURFACES OF SIMPLE LENSES"
Sov. J. Opt. Technol., 38, 684 (1971)
No abstract provided.

PURYAYEV, D.T.
"COMPENSATOR FOR INSPECTING THE QUALITY OF LARGE DIAMETER PARABOLIC MIRRORS"
Sov. J. Opt. Technol., 40 (1973)
A compensator is described for the title application, in the form of a single meniscus lens with a concave hyperbolic or parabolic surface, which can be used for parabolics up to 24 m focal length as well as for near parabolic hyperbolic surfaces. Diameter is less than 200 MM. Theoretical analysis of the geometry is given. Examples of application to mirrors with diameters in the range 1-6 m are given (9 Refs.).
Descriptors: OPTICAL TESTING; MIRRORS; LENSES
Identifiers: SINGLE MENISCUS LENS; PARABOLIC SURFACE; MIRRORS; GEOMETRY; QUALITY; LARGE DIAMETER PARABOLIC MIRRORS; COMPENSATOR; CONCAVE HYPERBOLIC SURFACE

ROSS, F.E.
"PARABOLIZING MIRRORS WITHOUT A FLAT"
Astrophys. J., 98, 341 (1943)
No abstract provided.

RUBEN, P.L.
"REFRACTIVE NULL CORRECTORS FOR ASPHERIC SURFACES"
Appl. Opt., 15, 3080 (1976)
The usefulness of a refractive null corrector is limited by how closely its aberrated wavefront can match the aspheric surface that requires testing. Guidance in both the design of the sphere to insure its nullability and the design of the null corrector is presented. A functional and constructional compendium of null corrector designs is proffered.

SCHUPMANN, L.
DIE MEDIAL-FERNROHRE: EINE NEUE KONSTRUKTION FUR GROSSE ASTRONOMISCHE INSTRUMENTE
Teubner, Leipzig (1899)
No abstract provided.

SILVERTOOTH, W.
"A MODIFICATION OF THE HINDLE TEST FOR CASSEGRAIN SECONDARIES"
J. Opt. Soc. Am., 30, 140 (1940)
No abstract provided.

SIMPSON, F.A., OLAND, B.H. and MECKEL, J.
"TESTING CONVEX ASPHERIC LENS SURFACES WITH A MODIFIED HINDLE ARRANGEMENT"
Opt. Eng., 13, 101 (1974)
No abstract provided.

VAN HEEL, A.C.S. and SIMONS, C.A.J.
"LENS AND SURFACE TESTING WITH COMPACT INTERFEROMETERS"
Appl. Opt., 6, 803 (1967)
No abstract provided.

WOLLENSAK, R.J. and ROSE, C.A.
"FABRICATION A TEST OF 1.8-METER-DIAMETER HIGH QUALITY ULE MIRROR"
Opt. Eng., 14, 539 (1975)
The purpose of this investigation was to determine the feasibility of producing large diameter, high quality optical surfaces similar to those that will be required for some of the planned orbital observing units such as the Large Space Telescope (LST). Current requirements for the Large Space Telescope requires that a lambda/20 rms wavefront be produced at the Cassegrain focus. A resonable distribution of error sources would, therefore, demand that the primary mirror be figured to as tolerance of lambda/64 rms on the surface. NASA has funded the initial step toward demonstrating the ability to meet that requirement. An optical fabrication demonstration program was undertaken using an available 1.8-meter-diameter ULE monolithic mirror blank weighing on the order of 1,200 pounds. The mirror that was used had no central perforation and was approximately 12 inches thick with 1-inch front- and back-plates. In order to accomplish this task, a variety of support and test equipment was designed and fabricated and the actual optical fabrication and test were conducted over a period of approximately eight months. The results off this efort yielded a mirror with a surface quality of 0.015 wave rms or lambda/65.3. (lambda=632.8 nanometers.)

BAYLE, A. and ESPIARD, J.
"SUR LA CONSTRUCTON DES GRANDS TELESCOPES D'ASTRONOMIE"
Nouv. Rev. Opt. Appl., 3, 67 (1972)
No abstract provided.

BERGMAN, T.G. and THOMPSON, J.L.
"AN INTERFERENCE METHOD FOR DETERMINING THE DEGREE OF PARALLELISM OF (LASER) SURFACES"
Appl. Opt., 7, 923 (1968)
No abstract provided.

BOHLIN, J.D.
"SIMULTANEOUS OPTICAL MONITORING OF ANGULAR AND TRANSLATONAL ALIGNMENT"
Appl. Opt., 11, 961 (1971)
No abstract provided.

BRUCE, C.F. and CUNINGHAME, W.A.F.
"MEASUREMENT OF ANGLE INTERFEROMETRY"
Aust. J. Appl. Sci., 1, 243 (1950)
No abstract provided.

BURGWALD, G.M. and KRUGER, W.P.
"AN INSTANT-ON LASER FOR LENGTH MEASUREMENT"
Hewlett Packard Journal, 21, 14 (1970)
No abstract provided.

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"A METHOD FOR PRECISION SPHEROMETRY OF CONCAVE SURFACES"
J. Phys., 4, 1060 (1971)
No abstract provided.

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"V. INTERFERENCE PHASE MEASUREMENT"
Appl. Opt., 8, 538 (1969)
The interfermeter to be described was deveoped to meet the need for an optical figure sensor capable of deriving on a real-time basis optical aligment and figure error data. Such a sensor is required to make possible contiuous automatic alignment of the primary mirror in a large telescope system. This interferometer is also useful for optical meterology in cases where a large number of data points are required in a relatively short time.

DE VANY, A.S.
"MAKING AND TESTING RIGHT ANGLE AND DOVE PRISMS"
Appl. Opt., 7, 1085 (1968)
No abstract provided.

DE VANY, A.S.
"REDUPLICATON OF A PENTA PRISM ANGLE USNG MASTER ANGLE PRISMS AND PLANO-INTERFEROMETER"
Appl. Opt., 10, 1371 (1971)
No abstract provided.

DEVE, C.
OPTICAL WORKSHOP PRINCIPLES
Hilger and Watts, London (1945)
No abstract provided.

DYSON, J.
INTERFEROMETRY AS A MEASURING TOOL
Machinery Publishing Co., Brighton (1970)
No abstract provided.

GUILD, J.
"NOTE ON PYRAMIDAL ERROR IN PRISMS"
Trans. Opt. Soc., 22, 139 (1920)
No abstract provided.

GUILD, J.
"ANGLE COMPARATORS OF HIGH PRECISSION FOR THE GONIOMETRY OF PRISMS"
Trans. Opt. Soc., 23, 297 (1921)
No abstract provided.

HARPER, D.C.
"A COMPARATIVE METHOD OF CHECKING ANGLES ON GLASS SAMPLES"
J. Phys., 1, 687 (1968)
No abstract provided.

HARPER, D.C.
"PREPARATION OF DRAWING OF OPTICAL ELEMENTS AND METHODS OF TESTING"
Appl. Opt., 9, 527 (1970)
No abstract provided.

HAYDEN, L.O. and MCCASKILL, T.B.
"OPTICAL CALIBRATION ANALYSIS OF THE U.S. NAVAL SPACE SURVEILLANCE SYSTEM"
Naval Research Lab., Wash. D.C. (1966)

A preliminary optical calibration of the U.S. Naval Space Surveillance System was made in 1961 usng graphical methods. Since then, calibration has been continued using better equipment and data reduction methods to determine more precisely the characteristics of the system. It is shown that the 108-MHz system studied is capable of measuring angles within a standard deviation of 1/2 min of arc at zenith. Electronic calibration methods used in setting up the 108-MHz system are shown to have a mean accuracy of approximately 3.5 percent of a wavelength for baselines up through 520 ft. in length. Bias errors for baselines of 1040 ft. and longer are larger than for the shorter baselines and must be corrected to obtain maximum accuracy from the system. Baselines in the range of 16 to 520 ft. have (for Echo passes) a mean standard deviation of plus or minus 0.034, which is independent of baseline length and angle of arrival and is internal to the system. The random error for longer baselines increases until it reaches a mean standard deviation of plus or minus 0.09 for the 5200- ft. baseline.

Descriptors: SPACE SURVEILLANCE SYSTEMS; CALIBRATON; RADAR TRACKING; NAVY; OPTICS; ANGLE OF ARRIVAL; PHASE (ELECTRONICS); PHASE MEASUREMENT; ERRORS, STATISTICAL ANALYSIS

HORNE, D.F.
"TESTING OPTICAL COMPONENTS"
Optical Production Technology
Adam Hilger, London, and Crane Russak, New York (1972)

No abstract provided.

JOHNSON, B.K.
CHAP VIII "OPTICAL GLASS: ITS WORKING AND TESTING"
CHAP II "FOCAL LENGTH MEASUREMENT"
Optics and Optical Instruments, Dover, New York (1947)

No abstract provided.

KENRICK, P.S.
"PRACTICAL ASPECTS OF THE USE OF OPTICAL TEST METHODS IN PRODUCTION"
Soc. Photo-Optical Instrumentation Eng., Palos Verdes Estates, California (1974)

It is no longer satisfactory to evaluate lenses by the visual appearance of the image they produce and objective test methods are becoming more commonly used in the optical workshop. The most important objective test parameters to be considered are optical tranfer functon, transmission, distortion and veiling glare.

Descriptors: OPTICAL INSTRUMENT TESTING; LENSES; OPTICAL IMAGES; TRANSFER FUNCTONS; OPTICAL WORKSHOP TECHNIQUES

Identifiers: OPTICAL TEST METHODS; PRODUCTION; OBJECTIVE TEST METHODS; OPTICAL WORKSHOP; OPTICAL TRANSFER FUNCTION; TRANSMISSION; DISTORTION; VEILING GLARE

KINGSLAKE, R.
APPLIED OPTICS AND OPTICAL ENGINEERING
Vol. I., Chap. II; Vol. III, Chaps. 2 & 5; Vol. IV, Chap. 7;
Academic Press, New York (1965)
No abstract provided.

KOLOMIITSOVA, T.S. and FEDINA, L.G.
"AN ANALYSIS OF THE TOLERANCES ON THE FABRICATION AND ALIGNMENT OF THE OPTICAL ELEMENTS OF THE IT-172 UNEQUAL-ARM INTERFEROMETER"
Sov. J. Opt. Technol., 43, 32 (1976)
The performance of the instrument is discussed and parameters effecting accuracy considered. Tolerances on fibraton and mounting of the interferometer elements are derived and are tabulted. It is shown that the aberratons of the objective lens should be equal and opposite to those of the beamsplitter cube for best performance (3 Refs.).
Descriptors: LIGHT INTERFEROMETERS; LENSES; OPTICAL PRISMS; OPTICAL DESIGN TECHNIQUES; OPTICAL TESTING
Identifiers: FABRICATON; ALIGNMENT; OPTICAL ELEMENTS;

KRYNIN, L.I. and GOLUBEV, O.S.
"STATISTICAL ESTIMATE OF LENS CENTERING ERRORS"
Sov. J. Opt. Technol., 42, 665 (1975)
An expermental deterimation is presented of the probablity density distributon law for lens decentering occurring due to entering in holders by autocollimation techniques. Results are plotted and compared with theoretical results in tables. The probability distributon obeys the normal distributon law for automatic centering and the Rayleigh for autocollimaton centering (5 Refs.).
Descriptors: OPTICAL TESTING; LENSES
Identifiers: LENS CENTERING ERRORS; PROBABILITY DENSITY DISTRIBUTION LAW; LENS DECENTERING; AUTOCOLLIMATION TECHNIQUES; AUTOMATIC CENTERING; RAYLEIGH LAW; STATISTICAL ESTIMATE

LEPPELMIER, G.W. and MULLENHOFF, D.J.
"A TECHNIQUE TO MEASURE THE WEDGE ANGLE OF OPTICAL FLATS"
Appl. Opt., 9, 509 (1970)
No abstract provided.

MALCARA, D. and HARRIS, O.
"INTERFEROMETRIC MEASUREMENT OF ANGLES"
Appl. Opt., 9, 1630 (1970)
No abstract provided.

MET, V.
"DETERMINATION OF SMALL WEDGE ANGLES USING A GAS LASER"
Appl. Opt., 5, 1242 (1966)
No abstract provided.

MURTY, M.V.R.K.
"INTERFERENCE BETWEEN WAVEFRONTS ROTATED OR REVERSED WITH RESPECT TO EACH OTHER AND ITS RELATION TO SPATIAL COHERENCE"
J. Opt. Soc. Am., 53, 1187 (1964)
No abstract provided.

NAESS, R.O.
"A MEASURNG INTERFEROMETER FOR HIGH ACCURACY ALIGNMENT"
Appl. Opt., 7, 2315 (1968)
No abstract provided.

NOBLE, R.H.
"CHAPTER 15. SOME PARAMETER MEASUREMENTS"
Optical Shop Testing, Malacara, D., Ed. (1978)

- 15.1 Length Measurement
  - 15.1.1 Radius of Curvature
  - 15.1.2 Back Focal Length and Focal Length
  - 15.1.3 Thickness of Optical Components
- 15.2 Angle Measurement
  - 15.2.1 Divided Circles
  - 15.2.2 Bevel Gauge
  - 15.2.3 Comparison Standards
  - 15.2.4 Fabrication Tolerances
- 15.3 Assembly Tolerances

RANK, D.H.
"CALIBRATION OF A SET OF MASTER WEDGES"
J. Opt. Soc. Am., 36, 116 (1946)
No abstract provided.

RATAJCZYK, F. and BODNER, Z.
"AN AUTOCOLLIMATIN MEASUREMENT OF THE RIGHT ANGLE ERROR WITH THE HELP OF POLARIZED LIGHT"
Appl. Opt., 5, 755 (1966)
No abstract provided.

SAUNDERS, J.B.
"SUGGESTED ARRANGEMENT OF MIRRORS TO FORM MULTIPLE REFERENCE ANGLES"
J. Opt. Soc. Am., 51, 859 (1961)
No abstract provided.

SAUNDERS, J.B.
"AN ALIGNMENT INTERFEROMETER"
Appl. Opt., 2, 541 (1963)
No abstract provided.

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"AN ALIGNMENT INTERFROMETER"
J. Res. Nat. Bur. Stand., 67, 307 (1963)
No abstract provided.

SCHNEIDER, E.J.
"THE AUTOCOLLIMATOR"
Opt. Spectra, 1, 24 (1967)
No abstract provided.

SEN, D. and PUNTAMBEKAR, P.N.
"SHEARING INTERFEROMETERS FOR TESTING CORNER CUBES AND RIGHT ANGLE PRISMS"
Appl. Opt., 5, 1009 (1966)
No abstract provided.

SHACK, R.
"TESTING"
Optical Shop Notebook, IX (1975)
No abstract provided.

SING, M., PANDEY, H.D., and SAWHNEW, P.R.
"MEASUREMENT OF ANGLES USNG A GAS LASER"
Optik (Stutt.) 33, 457 (1971)
No abstract provided.

SWYT, D.A.
"THE NATIONAL MEASUREMENT SYSTEM FOR OPTICS"
Nat. Bur. of Stand., Wash. D.C. Inst. for Basic Standards (1976)
NBS has conducted a study of the National Measurement System for Optics. The proposed system model is discussed includng the role of standards committees, instrument manufacturers and measurement users. The economic dimensions of the measurements impact areas and the tecnnological base from which new measurement technology springs are described.
Descriptors: OPTICAL MEASUREMENT; OPTICAL EQUIPMENT; STANDARDS; SYSTEMS ANALYSIS; DENSITOMETERS; INSTRUMENTATION; GOVERNMENT POLICIES; REGULATIONS; NATIONAL GOVERNMENT; STATE GOVERNMENT; LOCAL GOVERNEMNT; MICROSCOPES; OPTICAL LENSES;

PHOTOGRAPHIC EQUIPMENT; MICROFILM; RADIOGRAPHY, TESTS; INDUSTRIAL MANAGEMENT; QUESTIONAIRES; SURVEYS; LAW ENFORCEMENT

Identifiers: NATIONAL MEASUREMENT SYSTEM

TEW, E.J.
"MEASUREMENT TECHNIQUES USED IN THE OPTICAL WORKSHOP"
Appl. Opt., 5, 695 (1966)
No abstract provided.

TSURUTA, R. AND ICHIHARA, Y.
"ACCURATE MEASUREMENT OF LENS THICKNESS BY USNG WHITE-LIGHT FRINGES"
Jap. J. Appl. Phys., 14, 369 (1975)
No abstract provided.

TWYMAN, F.
PRISM AND LENS MAKING
Hilger and Watts, London (1957)
No abstract provided.

U.S. DEPARTMENT OF DEFENSE
MILITARY HANDBOOK 141
MIL-HDBK-141 (1963)
No abstract provided.

WASILIK, H., BLOMQUIST, T.V., and WILLETT, C.S.
"MEASUREMENT OF PARALLELISM OF THE SURFACES OF A TRANSPARENT SAMPLE USING TWO-BEAM NONLOCALIZED FRINGES PRODUCED BY A LASER"
Appl. Opt., 10, 2107 (1971)
No abstract provided.

WILLIAMS, T.L.
"STANDARD REFERENCE LENSES FOR THE INFRARED"
Soc. Photo-Optical Instrumentation Eng., Bellingham, WA (1976)

The design and construction of a standard reference lense for testing MTF equipment operatng in the thermal band (2 to 14 mum) is described. The results of some preliminary measurements with the lens are reported and discussed (4 Refs).

Descriptors: LENSES; OPTICAL DESIGN TECHNIQUES; MEASUREMENT STANDARDS; OPTICAL TRANSFER FUNCTION; OPTICAL INSTRUMENT TESTING;INFRARED IMAGING

Identifiers: INFRARED; DESIGN; CONSTRUCTION; STANDARD REFERENCE LENS; TESTING MTF EQUIPMENT; THERMAL BAND; 2 TO 14 MICRONS

ANDERSON, J.M. and LEE, L.
"ANALYTICAL IN-FLIGHT CALIBRATION (AERIAL CAMERA CALIBRATION)"
Photogramm. Eng. and Remote Sensing 41, 1337 (1975)

Discusses a general combined aerial triangulation and/or camera calibration program used to determine camera focal length, symmetrical radial lens distortion, and decentering lens distortion for a wild RC 8 aerial mapping camera equipped with aviogon lens No. 15 UAG.312. Three combinations of calibration parameters were utilized with four configurations of fixed ground control points using 14 and 21 photographs, respectively. Results are compared with each other and to the laboratory calibration of the lens. Calibrations with 21 photographs provide radial lens distortion curves which are fairly consistent and vary from the laboratory curve with discrepancies having RMSE of 1 micrometers. Tangential profiles are less consistent. Recovery of symmetric radial profiles are less consistent. Recovery of symmetric radial lens distortion parameters simultaneously with aerial triangulation is found to be feasible with photography having 60 percent all-around overlap and with a fixed control point array of moderate density. Use of these added calibration parameters yields an improvement in planimetric position and elevation of about thirty percent (10 Refs.).

Descriptors: PHOTOGRAPHIC APPLICATIONS; OPTICAL WORKSHOP TECHNIQUES; PHOTOGRAPHIC LENSES; CALIBRATION; OPTICAL INSTRUMENT TESTING; CAMERAS

Identifiers: AERIAL CAMERA CALIBRATION; SYMMETRICAL RADIAL LENS DISTORTION; AERIAL MAPPING CAMERA; CALIBRATION PARAMETERS; FIXED GROUND CONTROL POINTS; LABORATORY CALIBRATION; DISTORTION CURVES; AERIAL TRIANGULATION; ANALYTICAL INFLIGHT CALIBRATION; ANALYTICAL AEROTRIANGULATION; AERIAL PHOTOGRAPHY; CATOGRAPHY; DECENTRING LENS DISTORTION

ASSA, A., BETSER, A.A., and POLITCH, J.
"RECORDING SLOPE AND CURVATURE CONTOURS OF FLEXED PLATES USING A GRATING SHEARING INTERFEROMETER"
Appl. Opt., 16, 2504 (1977)

A diffraction grating shearing interferometer is presented which, depending on the recording procedure, can be used to measure directly the slopes and curvatures of specularly reflecting flexed plates. Three system arrangements are described: two for slope measurement and one for curvature. One slope arrangement yields results in real time but, in general, does not compensate for initial model curvature. The second requires an additional spatial filtering step but does compensate for the initial curvature. A diffraction theory approach is used to arrive at expressions for the complex field amplitude of the light at the output plane. This leads to expressions for the fringe values. Experimental results for three types of model are also presented. Errors of 2-4 analytical expression is derived and verified experimentally, which shows that when the system is used for measuring slope, the curvature of the model limits the measuring sensitivity. The theoretical analysis shows that this is a fundamental property of grating interferometers in general. This property is then explained as the basis of the curvatures measuring technique.

CHANDLER, C.H.
"A LENS-MEASURING INSTRUMENT-ENGINEERED FOR PEOPLE"
Opt. Eng., 13 275 (1974)
Describes a specialized instrument which can measure back focal lengths of lenses to +OR- 0.002 inches. It incorporates design features which promote quick convenient and accurate use by relatively untrained operators (4 Refs)
Descriptors: OPTICAL TESTING; LENSES
Identifiers: LENS MEASURING INSTRUMENT; MEASURING BACK FOCAL LENGTH; INSTRUMENT FOR UNTRAINED OPERATORS

COLEMAN, H.S., COLEMAN, M.F., and FRIDGE, D.L.
"THEORY AND USE OF THE DIOPTOMETER"
J. Opt. Soc. Am., 41, 94 (1951)
No abstract provided.

DYSON, J.
INTERFEROMETRY AS A MEASURING TOOL
Machinery Publishing Co, Brighton (1970)
No abstract provided.

EVANS, J.D.
"METHOD FOR APPROXIMATING THE RADIUS OF CURVATURE OF SMALL CONCAVE SPHERICAL MIRRORS USING A HE-NE LASER"
Appl. Opt., 10, 995 (1971)
No abstract provided.

EVANS, J.D.
"ERROR ANALYSIS TO: METHOD FOR APPROXIMATING THE RADIUS OF CURVATURE OF SMALL CONCAVE SPHERICAL MIRRORS USING A HE-NE LASER"
Appl. Opt., 11, 945 (1972)
No abstract provided.

GRUMET, A.
"A MOIRE TECHNIQUE FOR RAPID ALIGNMENT, FOCUS, AND SCALING OF IMAGERY"
Opt. Eng., 15, 460 (1976)
A rapid procedure is outlined that permits accurate alignment, focus, and scaling of imagery at two separated locations in an optical system. The moire pattern formed by pairs of identical gratings permits the full image pupil to be observed and adjusted. Alignment and scaling can be adjusted to an accuracy of the order of the grating's fundamental spacing.

HUNG, Y.Y., TURNER, J.L., TAFRALIAN, M. HOVANESIAN, J.D. and TAYLOR, C.E.
"OPTICAL METHOD FOR MEASURING CONTOUR SLOPES OF AN OBJECT"
Appl. Opt., 17, 128 (1978)

This paper presents a new coherent optical method whereby the partial derivatives of the contour of an object are measured. The object to be studied is immersed in a refractive medium and is imaged by a camera with a shearing device. The processed photographic plate which has been doubly exposed in the image plane with the refractive medium changed between the exposures can be Fourier filtered to yield a fringe pattern depicting derivatives of the surface contour with respect to the direction of shearing. This new method enjoys the adantages of being simple and less demanding in vibration isolation, coherence of light source, and film resolution.

MALYSHEVA, N.V. and BYLKINA, T.M.
"AN AUTOCOLLIMATING DEVICE FOR MEASURING RADII OF CURVATURE OF POLISHED CONCAVE SPHERICAL SURFACES"
Sov. J. Opt. Technol., 35, 310 (1968)

No abstract provided.

MARTIN, S.
"THE GLARE SPREAD FUNCTION AND ITS APPLICATION TO THE EVALUATION OF OPTICAL SYSTEMS"
Opt. Acta, 22, 389 (1975)

The traditional methods of measuring the glare characteristics have serious limitations. The numerical values obtained (glare indices) have no basic significance and depend upon both the geometry of the test apparatus and the glare characteristics of the lens. Furthermore, determination of the source of the glare and prediction of the glare performance for a lens used under different conditions are difficult. Alternative techniques are described using an elementary source in the object plane and a detector in the image plane, either of which can be scanned or maintained stationary in any desired position. The experimental illuminance distributions are normalized with respect to the flux in the image of the elementary source and the resulting curves have been designated glare spread functions. The paper contends that such glare spread functions provide a more satisfactory way of describing the glare characteristics of lenses than do the traditional methods.

Descriptors: OPTICAL TESTING; TRANSFER FUNCTIONS; LENSES; OPTICAL VARIABLES MEASUREMENT
Identifiers: OPTICAL SYSTEM EVALUATION; GLARE SPRE987AD FUNCTION; ILLUMINANCE DISTRIBUTIONS; ELEMENTARY SOURCE; LENSES

PATSTON, G.E.
"A METHOD OF CHECKING FOCAL LENGTH WHILE GRINDING"
Sky Telesc., 26, 358 (1963)

No abstract provided.

RANK, D.H.
"MEASUREMENT OF THE RADIUS OF CURVATURE OF CONCAVE SPHERES"
J. Opt. Soc. Am., 36, 108 (1946)

No abstract provided.

SCHULZ, G.
"A NEW METHOD OF MEASURING FOCAL LENGTH"
Optik (Stuttg.) 9, 167 (1952)
No abstract provided.

SHACK, R.
"TESTING"
Optical Shop N tebook, IX, 1 (1975)
No abstract provided.

SPEYER, G.
"THE INTERFERENCE SPHEROMETER"
Rev. Sci. Instrum., 14, 336 (1943)
No abstract provided.

TAYMAN, W.P.
"CALIBRATION OF LENSES AND CAMERAS AT THE USGS"
Photogramm. Eng., 40, 1331 (1974)
The photographic and visual tests are described along with the equipment used to measure calibrated focal length, distortion, resolving power, and model flatness. Also described are the most recent modifications to the USGS camera calibrator for complete testing of super-wide-angle cameras (4 Refs.).
Descriptors: PHOTOGRAPHIC LENSES: CAMERAS; OPTICAL INSTRUMENT TESTING; CALIBRATION
Identifiers: CAMERA LENS CALIBRATION; DEFORMATION TEST; COLLIMATOR REDUCTION RATIO; FOCAL LENGTH; DISTORTION; RESOLVING POWER; MODEL FLATNESS; CAMERA CALIBRATOR

TSURUTA, T., KISHI, M. and GONDA, T.
"AUTOMATIC VERTOMETER FOR SPHERICAL OPHTHALMIC LENSES"
Appl. Opt., 11, 2706 (1972)
No abstract provided.

WASHER, F.E.
"INSTRUMENT FOR MEASURING THE MARGINAL POWER OF SPECTACLE LENSES"
J. Opt. Soc., Am., 45, 719 (1955)
No abstract provided.

WINER, I.M.
"INTERFEROMETRIC DETERMINATION OF CONIC SECTIONS"
Optical Shop Notebook, IX, 74 (1975)
No abstract provided.

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16 ROUGHNESS MEASUREMENTS

AAS, J.A.
"RECONSTRUCTION OF SURFACE PROFILES FROM THEIR DIFFRACTION SPECTRA"
App. Opt., 11, 1579 (1972)

A possible method for reconstruction of two-dimensional, periodic surface profiles from their diffraction spectra is outlined. Formulas for the distribution of diffracted power, based on physical optics, are summarized and computed by approximating real profiles by piecewise linear functions. The profiles are reconstructed from measured spectra by a steepest descent method. A computer program searches for profiles whose spectra fit as close as possible to the measured spectra. For experimental demonstration a low-power CO2 laser is used as radiation source, and the roughness profiles of a turned metal cylinder are reconstructed and compared with traced profile curves.

BAKER, P.C., SONDERMAN, J.B., and SAITO, T.T.
"FINISHING OF PRECISION GENERATED METAL OPTICAL COMPONENTS"
Design Manufacture and Application of Metal Optics, 65,
Barnes, W.P., Ed. (1975)

Diamond turning and precision generation of aspehric metal surfaces has promoted a change in lapping techniques due to the extremely close figure tolerances and surface finishes that have been achieved. In order to polish the unusual aspheric figures, we utilized special tooling, diamond abrasive, and silicon oil and techiques which we will describe in detail. Our stuides include small flat diamond turned samples of copper, electroplated silver, electroplated nickel and silver as well as large aspheres such as an f/0.75, 35 cm diameter copper ellipse. Results from cleaning stuides on flat samples using ultrasonics and vapor degreasers will also be summarized. Interferograms of wavefront distortion and analysis of focal volume will be included as well as 10.6 mum reflectivity and a summary of laser damage experiments.

BAKER, P.C. and BROWN, N.J.
"POLISHING SINGLE-POINT DIAMOND-TURNED METAL REFLECTIVE OPTICS"
Lawrence Livermore Laboratory, Livermore, California (1978)

A procedure is described for the use of diamond-impregnated pitch and silicone oil which has produced surfaces which appear to be as smooth as 5 Angstrom rms on small flat samples removing the objectionable diffraction-producing grooves that sometimes accompany diamond turning. Possible mechanisms are described together with the procedures and equipment used to polish an x-ray microscope and a UV telescope.

BENEDETTI-MICHALANGELI, G.
"A NEW TECHNIQUE FOR THE EVALUATION OF THE QUALITY OF PLANE SURFACES"
Appl. Opt., 7, 712 (1968)

No abstract provided.

BENNETT, H.E.
"MEASUREMENT OF SMOOTH SURFACE FINISHES"
(1964)

Requirements for very smooth surface finishes are becoming more and more common in machine shop practice. In any application where there are running surfaces which must fit closely, the lubricating films separating these surfaces are only a few microinches thick and hence a very smooth surface finish is essential. Such tolerances are found, for example, in the microminiature bearings and shafts of gyroscopes. In addition, to list a few examples, the finishes of such diverse things as powder extrusion and metal drawing dies, plastic molds, refrigerator seals, packing rings, vacuum pump parts, and memory drums for high speed computers are critical.

Although reliable methods for measuring surface roughness in the 20 - 125 min. range have been in use for some time, no method in use today allows one to easily, accurately, and non-destructively meausre surface roughness in the 0.4 to 10 mum range. As a result, such surface finishes often must be determined by setting up and trying a powder die to see if powder piles up in it, or by making a statistical study which predicts that by using the present producing techniques a certain fraction of the rotors tested will run only 50 hours rather than 5000. It is the purpose of this article to suggest a simpler and less expensive technique.

In most cases it is necessary that any tests on very smooth surfaces be non-destructive. Therefore the appearance of a machined metal surface, supplemented perhaps by the fingernail test is perhaps most commonly used to estimate surface roughness[1]. An experienced machinist, if he knows what operations were used to machine a piece of work and if he is familiar with the characteristics of the alloy of which it is made, can estimate the surface roughness surprisingly accurately. The Navy Department and others have tried to place such visual determinations on a semi-quantitative basis by ensuing reflectance standards for ground turned milled or shaped steel surfaces having surface roughnesses of from 2 to 500 mum. These standards can be compared visually with the surface under test. Unfortunately, although the visual method for determining surface roughness is an easy technique. It cannot be made quantitative. Two surfaces, each having identical surface roughnesses but prepared by different machining operations or having different compositions, may have completely different appearances.

BENNETT, H.E. and STANFORD, J.L.
"STRUCTURE RELATED OPTICAL CHARACTERISTICS OF THIN METALLIC FILMS IN THE VISIBLE AND ULTRAVIOLET"
J. Research NBS, 80A, 643 (1976)

No abstract provided.

BENNETT, H.E.
"SCATTERING CHARACTERISTICS OF OPTICAL MATERIALS"
Opt. Eng., 17, 480 (1978)

In the visible and ultraviolet regions of the spectrum the dominant source of scattered light from optical components is surface scattering by microirregularities. They are typically only a few nanometers in height but cover the enitre optically polished surface. Since microirregularity scattering is inversely proportional to the square o^f the wavelength, the dominant source of scattering in the infrared is often microscopic defects such as scratches or digs. Pitting of the surface by sand or rain erosion also contributes to defect scattering. Dust particles and other particulates are a third important source of scattered light in the near infrared. When specifying the surface quality of the optical components to be used in low scatter applications, at least the rms microroughness of the surfaces and the scratch dig specification should be given. (An improved scratch standard would be most helpful here.) Better yet is a functional test is total integration scatter. A prototype instrument utilizing a Coblentz sphere and a HeNe laser operating at 3.39 mum, where the dominant source of scattering is scratches and other macroscopic defects, at 1.15 mum, where particulates such as dust may be important: and at 0.6328 mum, where microirregularity scattering dominates, has been constructed to perform this functional test. A simple theory allows us to extrapolate the results at these wavelengths to obtain a reasonably complete picture of the total integrated scattering behavior of the component at any wavelength. Additional data are required to understand the angular dependence of the scattered light since the angular dependence of scattered light is related to the slopes as well as the heights of the surface defects. Such data can be measured experimentally and analyzed to give a more complete picture of the surface than is obtainable from total integrated scattering measurements alone. However, both the measurements and the theoretical analysis are more complex. Angular scattering measurements at a single scattering angle are not by themselves sufficient to determine the rms surface microroughness.

BENNETT, H.
"STANDARDS FOR OPTICAL SURFACE QUALITY USING TOTAL INTEGRATED SCATTERING"
Conference on Standards for Scattering from Optical Surfaces,
Boulder, CO (1979) (unpublished).

No abstract provided.

BENNETT, J.M.
"MEASUREMENT OF THE RMS ROUGHNESS, AUTOCOVARIANCE FUNCTION AND OTHER STATISTICAL PROPERTIES OF OPTICAL SURFACES USING A FECO SCANNING INTERFEROMETER"
Appl. Opt., 15, 2705 (1976)

A brief review of techniques for measuring surface roughness and optical figure is given. One of the most promising of these techniques for measuring the roughness of optical surfaces in interferometry employing fringes of equal chromatic order (FECO). A FECO scanning interferometer is described, which has been used to determine statistics of polished surfaces having roughnesses under 100 A rms. The scanning interferometer resolve square surface elements 2 mum on a side and statistically characterizes the surface in terms of these elements. Height- and slope-distribution functions, rms roughness, rms slope, and modified autocovariance length distributions have been measured for selected optical surfaces. Nearly all surfaces had Gaussian distribution of heights and slopes, but none had Gaussian distribution of autocovariance lengths. Surfaces such as electropolished cooper, electroless nickel, and single-point diamond-machined copper were found to have smaller rms slopes than other surfaces of comparable roughness and scattered less than predicted by simple scalar scattering theory.[1,2] On the other hand, heavily scratched surfaces such as polished potassium chloride had larger slopes and produced more scattering than expected from simple theory.

BENNETT, J.M., BURGE, D.K., RAHN, J.P., and BENNETT, H.E.
"STANDARDS FOR OPTICAL SURFACE QUALITY USING TOTAL INTEGRATED SCATTERING"
SPIE Proceedings (1980)

Standards for optical surface quality are suggested to address two distinct problems: (1) the cosmetic appearance of the optical component and (2) its functional performance in an optical system. For the first problem, a series of standard scratches with appropriately defined profiles is suggested, so that the visual appearance of the standard scratch matches we suggest a measurement of total integrated scattering, which can be related quantitatively to the rms height of surface microirregularities. The scattering from scratches of different sizes can also be made quantitative. Angular scattering is too dependent on surface properties to permit it to be a useful standard. However, total integrated scattering is useful for approximately predicting the relative amounts of light scattered at a given angle by surfaces having different roughnesses.

BIGGS, F. and VITTITOE, C.N.
"CONCENTRATOR-QUALITY EVALUATION"
Meeting of the American Section of the International Solar Energy Society, Denver, CO, (1978)

The performance of a reflecting solar concentrator depends, or course, on its surface reflectance, but there are other important factors.

Among these are sun-tracking errors, surface-slope errors, and surface irregularities. It is appropriate to use statistics to describe and analyze these non-deterministic factors. A scheme for specifying the quality of a solar concentrator that includes all these effects is described and illustrated. It is believed that htis procedure is optimum in the sense that it requires a minimum of measurements to obtain a complete enough description of concentrator to determine its optical performance under any operating geometry. The specification scheme is, therefore, suitable for use in general systems analysis studies involving solar concentrators. (ERA citation 04:005623)

Descriptors: SOLAR CONCENTRATORS, SOLAR REFLECTORS, ERRORS, FLUX DENSITY, GEOMETRY, HELIOSTATS, OPTICS, PERFORMANCE, SOLAR FLUX, SOLAR TRACKING, STATISTICS

Identifiers: ERDA/141000, SOLAR ENERGY CONCENTRATORS, NTISDE

BIRKEBAK, R.C.
"OPTICAL AND MECHANICAL RMS SURFACE ROUGHNESS COMPARISON"
Appl. Opt., 10, 1971 (1970)

No abstract provided.

BRIERS, J.D.
"INTERFEROMETRIC FLATNESS TESTING OF NONOPTICAL SURFACES"
Appl. Opt., 10, 519 (1971)

An interferometric method of testing the flatness of nonoptical surfaces is described. The method consists essentially of introducing light to the surface at near grazing incidence; this is effected by using an isosceles glass prism, the base of which is the reference surface. The technique can utilize diffuse daylight as a light source and provides a quick and easy method of assessing the flatness of such items as smoothed glass flats prior to polishing, flat metal laps, and other nonoptical surfaces.

BRUNING, J.H., HERRIOTT, D.R., GALLAGHER, J.E., ROSENFELD, D.P., WHITE, A.D., and BRANGACCIO, D.J.
"DIGITAL WAVEFRONT MEASURING INTERFEROMETER FOR TESTING OPTICAL SURFACES AND LENSES"
Appl. Opt., 13, 2693 (1974).

No abstract provided.

BUNNAGEL, R., OEHRING, H.A., and STEINER, K.
"FIZEAU INTERFEROMETER FOR MEASURING THE FLATNESS OF OTPICAL SURFACES"

A Fizeau interferometer is described with which to test the flatness of optical surface up to 240-mm dia. A mercury mirror of suitable diameter is used as a flatness standard. A simple 240-mm diam. lens is sufficient. For easy testing of the surfaces of wedge-shaped glass plates without adjustment difficulties the illumination and photographic arrangement, mounted in the same frame, can be tipped on an axis, going through the test surface. The influence of the aberration of the simple lens is discussed. Experimental results of the measurement of an optical flat are presented.

CHURCH, E.L., JENKINSON, H.A., and ZAVADA, J.M.
"MEASUREMENT OF THE FINISH OF DIAMOND-TURNED METAL SURFACES BY DIFFERENTIAL LIGHT SCATTERING"
Opt. Eng., 16, 360 (1977)

This paper discusses the measurement of the finish of diamond-turned surfaces by differential light scattering. Experimental scattering data are analyzed by electromagnetic theory to give the two-dimensional power spectral density of the surface roughness. These spectral densities are direct functonal measures of te surface quality, and may be characterized in terms of topographic finish parameters. These parameters can then be used to specify surface finish, to predict scattering under a variety of conditions, and to aid in studies of other functional properties of these surfaces. Scattering spectra are separated into three groups corresponding to three classes of surface roughness: periodic tool marks give rise to discrete diffraction lines in the scattering spectrum and are characterized by their surface periods and their Fourier amplitudes. Random one- and two-dimensional roughness give rise to one- and two-dimensional continua underlying the diffraction lines and are characterized by band-liminted values of the rms surface heights and slopes, and transverse length parameters. Using HeNe light, vertical roughnesses are measured from a fraction of an Angstrom to several hundred Angstroms, for transverse spatial wavelengths from a fraction of a micron to several hundred microns. We review experimental techniques for making these measurements with emphasis on the scatterometer developed in our laboratory, which uses a fixed source-detector geometry and a rotating sample. Results are illustrated by a number of scattering spectra taken with this instrument.

CURCIO, M.E.
"EVALUATION OF LOW-SCATTER TECHNOLOGY FOR ASPHERIC METAL MIRRORS"
Proceedings of the SPIE, 65, (1976)

An evaluation of the off-specular scatter from a metal mirror is required for those radiometric systems where high off-axis rejection is achieved through low-scatter primary optics. Thjs paper addresses the testing procedures for determination of the bi-directional reflectance distribution function (BRDF) at 10.6mum, handling techniques for the prevention of degraded mirror performance through contamination, and the low-scatter performance achieved by the current fabrication technology for large, aspheric samples. The statistics of mirror surface sampling is also presented, as well as the distribution of the resultant measurements for a significant sampling of the surface area. The latter are used to demonstrate the impact that various type of surface imperfections have on low-scatter performance, as well as indicate typical behavior for the better low-scatter mirrors. These statistics also indicate the best performance that can be anticipated under the present technology once these imperfections are eliminated.

DECKER, D.L. and GRANDJEAN, D.J.
"PHYSICAL AND OPTICAL PROPERTIES OF SURFACES GENERATED BY DIAMOND-TURNING ON AN ADVANCED MACHINE"
Naval Weapons Center, China Lake, CA

A superprecision, two-axis, air-static bearing, diamond-turning machine of advanced design has been previously described at this Conference and is now operational. The microtopography and other physical characteristics of surfaces turned by this machine will be examined in detail. Some effects of machining parameters will be briefly discussed. The ability of this machine to turn surfaces with very small slope errors (less than 10^{-3}) and small rms roughness (approx. 10 A) is discussed with relation to the resulting optical absorption, scattering, and laser damage resistance. The characteristics of the machine which permit these high quality surfaces are identified, and some projections are given to the future application of diamond-turned optics at near infrared or visible wavelengths.

Key Words: ABSORPTION; DIAMOND-TURNING; SCATTERED LIGHT; SURFACE ROUGHNESS

DECKER, D.L. and BENNETT, J.M.
"SURFACE EVALUATION TECHNIQUES FOR OPTICAL COMPONENTS"
Naval Weapons Center, China Lake, CA

Maximum energy throughput, good image forming qualitites, and low scattered light levels are all desirable in high performance optical systems. Mirrors need to have a good optical figure, high reflectance, and low scatter. Windows and other transmitting optics should have low intrinsic absorption, low surface absorption and scatter, minimum bulk scattering, and a good optical figure. Optical figure is usually readily evaluated, but microroughness and scratches and digs which affect optical scattering are more difficult to measure quantitatively. This paper presents a brief description of several optical characterization techniques which include methods for measuring surface microtopography, scattered light, absolute reflectance, change in reflectance with temperature, and optical absorption. In addition, an objective, nondestructive technique which can supplement or eliminate visual scratch/dig measurements is discussed.

DENNY, C., SPRAWR, W.J., and PIERCE, R.L.
"METAL MIRROR SELECTION GUIDE UPDATE"
SPAWR Optical Research, Inc., Corona, California 91720

Two additions to the popular "Metal Mirror Selection Guide" are proposed. To aid in specifying metal mirrors, some common terms and uses must be resolved. Mirror surface finish, contour, and outline shape, as well as aspect ratio, all affect both prices and quality. Part one definitizes these issues. Proper mounts for metal optics present a seemingly impossible design problem. Common design faults and their affects on optics present severe obstacles to proper system function. A well proven approach - called dual interfacing, has proven to be unusually effective in correcting these problems. Part two of this paper discussed and illustrates the problem as well as the working solution.

DEPEW, C.A. and WEIR, R.D.
"SURFACE ROUGHNESS DETERMINATION BY THE MEASUREMENT OF REFLECTANCE"
Appl. Opt., 10, 969 (1971)

No abstract provided.

DEVANY, A.S.
"OPTIGAMI - A PROFILING TOOL FOR PITCH POLISHERS"
Appl. Opt., 10, 661 (1970)

No abstract provided.

DIL, J.G., GREVE, P.F., and MESMAN, W.
"MEASUREMENT OF STEEP ASPHERIC SURFACES"
Appl. Opt., 17, 553 (1978)

A method of measuring the shape of high numerical aperture (NA less than 0.95), convex of concave, aspheric surfaces is described. The aspheric slope may be as large as 1200 waves/rad. The method is applied in two steps. First, a standard measurement is performed to obtain a reference surface. Second, the reproducibility of the fabrication of aspheric surfaces is tested by means of a holographic comparison method. The measuring error is smaller than 0.1 micrometers.

ELSON, J.M. and BENNETT, J.M.
"RELATION BETWEEN THE ANGULAR DEPENDENCE OF SCATTERING AND THE STATISTICAL PROPERTIES OF OPTICAL SURFACES"
J. Opt. S

N O

L PECKLE TECHNIQUES"
Opt. Commun., 16, 68 (1975)
The statistical properties of speckle intensity variations produced by coherent light in the far-field diffraction plane of an illuminated area of an object are studied experimentally as a function of the radius of an illuminating beam over the object and are found to have a relation to its surface roughness and correlation lengths. Measurements of the surface roughness and the correlation length become possible by investigating the contrast variation of the speckle intensity as a function of the radius of the illuminating beam.

FUJII, H. and ASAKURA, T.
"DEVELOPMENT OF LASER SPECKLE AND ITS APPLICATION TO SURFACE INSPECTIONS"
Appl. Opt., 16, 180 (1977)
The growth of granularity in partially developed speckle patterns produced in the near field of wave object surfaces under illumination of laser light has been experimentally investigated. The average contrast of intensity variations in near-field speckle patterns due to three kinds of objects having different surface qualities has been measured as a function of the receiving distance from the object surface. It is found that a variation of the speckle contrast against the receiving distance is closely related to the surface waviness of objects. On the basis of this relation, a new and simple method is proposed to inspect the surface quality of objects.

FUJII, H. and ASAKURA, T.
"ROUGHNESS MEASUREMENTS OF METAL SURFACES USING LASER SPECKLE"
J. Opt. Soc., Am., 67, 1171 (1977)
No abstract provided.

FUJII, H. and LIT, J.W.
"SURFACE ROUGHNESS MEASUREMENT USING DICHROMATIC SPECKLE PATTERN: AN EXPERIMENTAL STUDY"
Appl. Opt., 17, 2690 (1978)

Surface roughness is studied experimentally by making use of the statistical properties of dichromatic speckle patterns. The rms intensity difference between two speckle patterns produced by two argon laser lines are analyzed in the far field as functions of the object surface roughness and the difference in the two wavenumbers of the illuminating light. By applying previously derived formulas, the rms surface roughness is obtained from rms intensity differences. Glass and metal rough surfaces are used. Other than the scattering arrangement, the experimental setup has a simple spectrometric system and an electronic analysis circuit.

GAFFARD, J.P. "METHOD AND APPARATUS OF DETECTING FLAWS IN TRANSPARENT BODIES" Appl. Opt., 7, 2338 (1968)

This invention describes a device to test surface quality and refractive index gradients of polished glass plates. The method employed is essentially a modified Foucault test, where the plate under investigation is placed at an intermediate focal plane of the system while any change in light conditions at a photoelectric detector will indicate surface quality or refractive index changes.

GOODMAN, J.W.
"DEPENDENCE OF IMAGE SPECKLE CONTRAST ON SURFACE ROUGHNESS"
Opt. Commun., 14, 324 (1975)

No abstract provided.

HARD, S. and NILSSON, O.
"LASER HETERODYNE APPARATUS FOR ROUGHNESS MEASUREMENTS OF POLISHED SURFACES"
Appl. Opt., 17, 3827 (1978)

A laser heterodyne apparatus for roughness measurements of polished surfaces has been developed. A new principle for generation of the local-oscillator light beam is introduced. Important features of the apparatus are: very high sensitivity (R_a values less than 0.1 nm can readily be measured), immunity against stray light of all kinds, noncritical aligning (insensitvie to vibrations), simple configuration, microprocessor output unit for digital presentation of characteristic surface measures. A quantitative theory of the complete apparatus is presented together with experimental confirmation by comparisons with stylus and multiple interference measurements.

HILDEBRAND, B.P., HAINES, K.A., and LARKIN, R.
"HOLOGRAPHY AS A TOOL IN THE TESTING OF LARGE APERTURE OPTICS"
Appl. Opt., 6, 1267 (1967)

This paper describes applications of holography to the testing of large optical surfaces. In one application a hologram of the wavefront from the mirror is made with a pulsed laser and then used in place of the mirror for Foucault knife-edge testing. This allows the mirror to be tested in its working environment. In the second application the hologram is made in the same manner, but is used in a common path interferometer where the reconstructed point image of the mirror is interfered against a point source to show the difference between the mirror surface and a reference sphere.

HILDEBRAND, B.P.
"A HOLOGRAPHIC INSTRUMENT TO REPLACE THE TEST GLASS IN LENS TESTING"
Opt. Eng., 15, 24 (1976)

This paper describes the development of a holographic instrument designed to take the place of the test glass in testing lens surfaces. The objective was to produce an instrument giving similar results as the test glass, while preserving its simplicity. The research performed in this project resulted in a very simple system wherein a single hologram contains a complete interferometer supply both the illumination source and the reference.

The instrument is designed to be used on lens surfaces without the need to remove them from the mandrel of the polishing machine. It is simply placed on the optical surface, contacting it at three points. Fringes similar to those obtained with a test glass are seen on a screen on the instrument. Each lens design requires a hologram specifically made to test its particular curvature. Since the holograms can be made cheaply and rapidly, considerable cost savings should result, since on precision test glasses need be made.

HODGKINSON, I.J.
"THE APPLICATION OF FRINGES OF EQUAL CHROMATIC ORDER TO THE ASSESSMENT OF THE SURFACE ROUGHNESS OF POLISHED FUSED SILICA"
J. Phys., 3, 300 (1970)

No abstract provided.

HODGKINSON, I.J.
"A SIMPLER SCATTER METHOD FOR OPTICAL SURFACE ROUGHNESS AND SLOPE MEASUREMENTS: ROUGHNESS OF POLISHED FUSED SILICA"
J. Phys., 3, 341 (1970)

No abstract provided.

HOFFMAN, R.A., LANGE, W.J., GOWAM, J.G., and MIGLIONICO, C.J.
"ION POLISHING AS A SURFACE PREPARATION FOR DIELECTRIC COATING OF DIAMOND-TURNED OPTICS"

A technique to improve the adherence of multilayer dielectric coatings to diamond-turned copper mirror surfaces was developed. The method employs carefully controlled ion polishing, vaccum annealing, and in situ coating of the mirror substrates. It was found that ion polishing the substrates, with as little as 100 A removed, prior to coating improved the film adhesion significantly. All of the samples prepared in this manner passed all of the standard ASTM mechanical tests while control samples produced by conventional methods failed the tests. Additional coating evaluation such as reflectivity and laser damage threshold measurements at 10.6 micrometers, auger analysis for contaminants in the films and at interfaces, SEM characterization, and x-ray energy dispersive analysis are also discussed.

JAERISCH, W. and MAKOSCH, G.
"OPTICAL CONTOUR MAPPING OF SURFACES"
Appl. Opt., 12, 1552 (1973)

A precise nondestructive optical contour mapping method with adjustable sensitivity for noncontact testing of surface deformations up to 30 micromenters/cm is described. The method employs an optical grating that is placed in from on the test surface. Illumination of the grating by a monochromatic plane wave generates an interference pattern between the beam components of two different diffraction orders. Reflection at the test surface and superposition with the fixed grating generate a finge pattern that resembles the surface contours of the test object. This fringe pattern consists of a superposition of an interference line system and a moire line system. Whereas the distance between two adjacent contour lines of the interference pattern corresponds to a surface deformation of a half-wavelength of the illuminating light the distance between two lines of the moire system is determined by the grid constant and the direction of the grid illumination. Therefore, the scale of measurement can be chosen according to the problem. Applications for surface flatness testing of semiconductor wafers and photomasks are presented.

JAERISCH, W. and MAKOSCH, G.
"INTERFEROMETRIC SURFACE MAPPING WITH VARIABLE SENSITIVITY"
Appl. Opt., 17, 740 (1978)

In the photolithographic process, presently employed for the production of integrated circuits, sets of correlated masks are used to exposing the photoresist on silicon wafers. Various sets of masks which are printed in different printing tools must be aligned correctly with respect to the structures produced on the wafer in previous process steps. Even when perfect alignment is considered, displacements and distortions of the printed wafter patterns occur. They are caused by imperfections of the printing tools or/and wafer deformations resulting from high temperature processes. Since the electrical properties of the final integration circuits and therefore the manufactuing yield depend to a great extent on the precision at which such patterns are superimposed, simple and fast overlay measurements as well are very important in IC-manufacturing. A simple optical interference method for flatness measurements will be described which can be used under manufacturing conditions. This method permits testing of surface height variations by nearly grazing light incidence by absence of a physical reference plane. It can be applied to polished surfaces and rough surfaces as well.

JUREK, B.
"OPTICAL SURFACES ASPHERICAL OPTICAL SYSTEMS, X-RAY OPTICS,
REFLECTING MICROSCOPES, REFLECTORS, MEASUREMENTS.
Appl. Opt., 16, 2337 (1977)

Aspheric surfaces gain more and more practical importance. However, there is only a comparatively small number of books on the design of aspherics available. New publications are, therefore, especially welcome. In Jurek's book the emphasis is on the treatment of aspheric surfaces, and the title chosen by the author does not mean that the total domain defined in this way is dealt with exhaustively.

KALE, B.M. and BROOME, B.
"IN SITU BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTION (BRDF) MEASUREMENT FACILITY"
Aerojet Electro Systems Company, CA (1979)

The angular distribution of light scattered from optical surfaces is best described by a Bidirectional Reflectance Distribution Function (BRDF). Scattered light in spaceborne optical systems may be induced by surface contaminants that are present only under the combined conditions of extreme cold, high vacuum, and strong ultraviolet radiation. An instrument is described that generates surface contaminants and measured BRDF in situ. Measurements are performed at the 10^{-8} Torr pressure and at 77K for angular scatter ranging from one degree away from the specular reflected beam to sixty degrees away from the specular reflected beam. Measured BRDF intensity ranges from 10^{-0} watt per incident watt per steradian to 10^{-6} watt per incident watt per steradian.

KELLY, W.L., BURCHER, E.E., and SKOLAUT, M.W.
"AN OPTICAL PROFILOMETER FOR SPATIAL CHARACTERIZATION OF THREE-DIMENSIONAL SURFACES"
Langley Research Center, Rept. No. NASA-TP-1012 (1977)

The design concept and system operation of an optical profilometer are discussed, and a preliminary evaluation of a breadboard system is presented to demonstrate the feasibility of the optical profilometer technique. Measurement results are presented for several test surfaces; and to illustrate a typical application, results are shown for a cleft palate cast used by dental surgeons. Finally, recommendations are made for future development of the optical profilometer technique for specific engineering or scientific applicaitons.

Descriptors: OPTICAL MEASURING INSTRUMENTS; PHOTOELASTIC ANALYSIS; PROFILOMETERS; EQUIPMENT SPECIFICATIONS; ELECTRO-OPTICS; MINICOMPUTERS; OPTICAL DATA PROCESSING; STEREOPHOTOGRAPHY

Identifiers: DENTAL EQUIPMENT; MEDICAL EQUIPMENT; DESIGN; NTISNASA

KESSLER, E.G.
"STATE-OF-THE-ART SURVEY FOR AUTOMATIC OPTICAL DETECTION OF SURFACE DEFECTS ON ORDNANCE MATERIAL"
Picatinny Arsenal Dover, NJ, Technical Report, Rept. No. PA-TR-4880

The state-of-the-art survey is aimed towards optical procedures that might prove useful in detecting defests (such as cracks, blemishes, pits, and missing or out-of-tolerance components) typically found in ordnance items. Included in this report are sections on color diffraction, reticles, scatter, optical spatial filters, mechanical and electronic optical scanning systems, and analog-digital electronic information analysis. It is found in general that the ability to resolve a defect has an inverse relationship to the complexity of the background. If the background is sufficiently subdued, a simple photodetector circuit will serve. It is concluded that the design engineer must carefully evaluate the specific problem in order to obtain the simplest, most cost effective defect detection system that meets quality control criteria.

Descriptors: OPTICAL DETECTION; DEFECTS (MATERIALS);

ORDNANCE; NONDESTRUCTIVE TESTING; SURFACES; AMMUNITION; AUTOMATIC; TOLERANCES (MECHANICS); MATERIALS; OPTICS; PATTERN RECOGNITION; QUALITY CONTROL; CRACKS; BLEMISHES; PITTING; COLORS; DIFFRACTION; RETICLES; SCATTERING; SPATIAL FILTERING; OPTICAL FILTERS; ELECTRONIC SCANNERS; OPTICAL SCANNING; COST EFFECTIVENESS

KOEHLER, W.F. and WHITE, W.C.
"MULTIPLE BEAM FRINGES OF EQUAL CHROMATIC ORDER. PART VI. METHOD OF MEASURING ROUGHNESS"
J. Opt. Soc. Am., 45, 1011 (1955)
No abstract provided.

LOEWEN
"METROLOGY FOR OPTICAL ELEMENTS"
Opt. Shop Notebook, IX, 27 (1975)
No abstract provided.

MAKOSCH, G. and JAERISCH, W.
"MAPPING OF OPTICAL SURFACES WITH QUARTER WAVELENGTH FRINGES"
Appl. Opt., 17, 744 (1978)
A contactless interference surface testing method is described that is capable of creating fringe patterns with fringe separations corresponding to a surface deformation of a quarter-wavelength of the illumination light. Contrary to common Fizeau fringes where the interference pattern occurs by superposing two wavefronts, the described method is based upon a superposition of four wavefronts. These wavefronts are created by a diffraction transmission grating which is contactlessly placed over the surface to be tested. Basically, this technique provides a beat frequency pattern with adaptable fringe separation. Practial applications of this method to semiconductor silicon wafers are presented.

MALACARA, D. and CORNEJO, A.
"TESTING OF ASPHERICAL SURFACES WITH NEWTON FRINGES"
Appl. Opt., 9, 837 (1970)
The shape of any aspheric surface with rotational symmetry can be very easily found with great accuracy using Newton fringes formed against a spherical test plate. To make it possible, a special mathematical procedure is devised for use with a special measuring system here described.

MARTIN, S.
"INFLUENCE OF SURFACE DEFECTS ON THE GLARE CHARACTERISTICS OF A NIGHT VISION SYSTEM WITH REFRACTIVE OPTICS"
Opt. Acta, 25, 1113 (1978)
In order to prepare the optical specifications for night vision systems a study opf

their glare characteristics is required. Such systems use lenses of very high aperture and, as the information content of the signal is lower than in the daylight equivalent, the glare characteristics are particularly important. This is a study of a particular night vision system that incorporates a channel intensifier tube, 18 mm in diameter, and a refractive objective. The object of the investigation was to study the glare characteristics of the optics, the tube and the complete system and to evaluate the glare due to surface defects on the optical components (8 Refs.).

Descriptors: OPTICAL SYSTEMS; IMAGE INTENSIFIERS; LENSES; INFRARED IMAGING

Identifiers: SURFACE DEFECTS; GLARE CHARACTERISTICS; NIGHT VISION SYSTEM; REFRACTIVE OPTICS; LENSES; VERY HIGH APERTURE; CHANNEL INTENSIFIER TUBE; REFRACTING OBJECTIVE

MOORE, W.T.
"TESTING OF SPHERICAL SURFACES BY HOLOGRAPHIC INTERFERENCE"
Appl. Opt., 15, 831 (1974)

This invention provides an improved technique for testing sphericity which avoids the use of a spherical reference surface. It can provide an absolute measure of the sphericity of an object. The method involves forming a vertual image from a hologram plate at the same point as that as which a beam illuminating the surface under test is focused. The illuminating beam is reflected at the surface and forms interference fringes with the beam from the hologram. The fringes indicate departures of the surface under test from true sphericity.

MOREAU, B.G. and HOPKINS, R.E.
"APPLICATION OF WAX TO FINE GROUND SURFACES TO SIMULATE POLISH"
Appl. Opt., 8, 2150 (1969)

No abstract provided.

MUNNERLYN, C.R. and LATTA, M.
"ROUGH SURFACE INTERFEROMETRY USING A CO_2 LASER SOURCE"
Appl. Opt., 7, 1858 (1968)

It is well known that the specular component of the scattered field increases with increasing wavelength for a random rough surface. For a sufficiently long wavelength, optically rought surfaces behave similarly to smooth surfaces that can be measured by interferometric techniques. The CO_2 laser with a wavelength of 10.6 micrometers offers the necessary increase in wavelength, while it retains sufficient accuracy to make useful measurements on optically rough surfaces.

In a Twyman-Green interferometer, the fringes of equal thickness are localized in the vicinity of the surface being measured. A relationship between the fringe contrast and the surface roughness can be calculated by considering the average intensity at each point when wavefronts reflected from a smooth surface and a rough surface are added together.

Surface irregularities, which are small compared with the wavelength used, introduce only phase errors in the wavefront. For normal incidence, the magnitude of the error is phi = 2k xi, where k = 2 pi/lambda, xi is the height of the rough surface measured from a zero mean, and the factor of 2 is required to account for the double path on reflecting.

OHTSUBO, J. and ASAKURA, T.
"MEASUREMEWNT OF SURFACE ROUGHNESS PROPERTIES USING SPECKLE PATTERNS WITH NON-GAUSSIAN STATISTICS"
Opt. Commun., 25, 315 (1977)

The surface roughness properties (i.e., the rms surface roughness and the correlation length) of strong diffuse objects are investigated by using the speckle patterns which obeys the non-gaussian statistics. The intimate linear relation is found to exist between the rms surface roughness of objects and the maximum contrast obtained from the varying curves of the average image speckle contrast as a function of the point spread of an optical image system. The correlation length of surface roughness of objects is related to the average intensity distribution of speckle patterns produced at the far-field diffraction plane. It now becomes clear that the rms roughness and the correlation length of strong diffuse objects are determined, respectively, from the maximum speckle contrast at the image plane and the average speckle intensity distribution at the far-field diffraction plane.

PARKS, R.E., SUMMER, R.E., and STRITTMATTER, R.E.
"POLISHING SINGLE POINT DIAMOND TURNED MIRRORS"
OSA, SAN MATEO, (1977)

A method of removing the high frequency microripple from single point diamond machined mirrors has been developed. The process uses conventional hand polishing techniques and laps of sufficient rigidity to bridge the microripple yet soft enough not to scratch the metal mirror surface. Substantial material must be removed from the mirror surfaces in some cases and the surface figure may be degraded unless careful testing is done during the process. We present photographs showing the reduction in scattering and improvement in mirror surface roughness as the result of the polishing. Phase-contrast microphotographs also show that the polished surface is almost as free of mechanical defects (scratches and pits) as the original virgin turned metal surface.

PLATZECK, R. and GAVIOLA, E.
"ON THE ERRORS OF TESTING AND A NEW METHOD OF SURVEYING OPTICAL SURFACE AND SYSTEMS"
J. Opt. Soc. Am., 29, 484 (1939)

No abstract provided.

READY
"MEASUREMENT OF SURFACE FINISH"
Ind. Appl. of Lasers, 331 (1978)

No abstract provided.

RHEN, V., STANFORD, J.L., BAER, A.D., JONES, V.O., and CHOYKE, W.J.
"TOTAL INTEGRATED OPTICAL SCATTERING IN THE VACUUM ULTRAVIOLET: POLISHED CVD SIC"
Appl. Opt., 16, 1111 (1977)
No abstract provided.

REICH, F. and COLEMAN, W.J.
"HIGH-SPEED SURFACE FLAW INSPECTION"
Opt. Eng., 15, 48 (1976)
An optical surface flaw inspection monitor has been developed as a part of Frankford Arsenal's Cartridge Case Measurement Eject System for 5.56 mm small-caliber ammunition. This surface flaw monitor uses scattered light electro-optical instrumentation to detect flaw presence on 100% of the cartridge cases surface at case throughput rates exceeding 1200 cases/minute. A line source formed from a laser source with cylindrical optics automatically tracks a spinning cartridge on the perimeter of a wheel-type mechanical handling system. Individual fiber optic elements located at each case position direct scattered light from surface zones of the case to common photomultiplier-based optical detectors. The detected signals are corrected for illumination and receiving optics transmissions and then frequency-processed. The frequency pattern of the detected scattered light related directly to the type of surface flaw, such as dents and scratches. Go, no-go signals are fed directly to a minicomputer for implementation of a reject function on the mechanical handling hardware.

RIBBONS, W.B.
"INTERFEROMETRIC SURFACE ROUGHNESS MEASUREMENT"
Appl. Opt., 8, 2173 (1969)
No abstract provided.

RIBBENS, W.B.
"SURFACE ROUGHNESS MEASUREMENT BY HOLOGRAPHIC INTERFEROMETRY"
Appl. Opt., 11, 807 (1972)
This paper presents a method of measuring the roughness of a reflecting surface by studying the contrast ratio of a holographic interference pattern of this surface. A practial experimental configuration is illustrated along with the measurement results obtained for a set of lapped steel specimens. In addition, an approximate scalar theory is presented that correlates well with experiment.

ROESLER, F.L. and TRAUB, W.
"PRECISION MAPPING OF PAIRS OF UNCOATED OPTICAL FLATS"
Appl. Opt., 5, 463 (1966)
The essential features of apparatus suitable for routine mapping of pairs of wedged uncoated optical flats are described. In this method the aperture of the pair of flats is canned in a regular pattern, and information about the spacing uniformity is derived from the interference of light reflected from the flat surfaces. Accuracies within about lambda/500 are obtained.

ROWE, S.H. and WELFORD, W.T.
"SURFACE TOPOGRAPHY OF NON-OPTICAL SURFACES BY PROJECTED INTERFERENCE FRINGES"
Nature, 216, 786 (1967)
No abstract provided.

SAITO, T.T., MILAM, D., BAKER, P., and MURPHY, G.
"1.06 MICROMETERS 150 PSEC LASER DAMAGE STUDY OF DIAMOND TURNED, DIAMOND TURNED/POLISHED AND POLISHED METAL MIRRORS"
Lawrence Livermore Laboratory, Livermore, CA Rept. No. UCRL-7822 (1975)
No abstract provided.

SAITO, T.T.
"DIAMOND TURNING OF OPTICS"
Opt. Eng., 15, 431 (1976)
Recent developments in diamond turning of optics are reviewed. Improved surface figure and surface finish have been achieved as well as metrology of the machined part. Reflectivities of diamond turned metals at various wavelengths are summarized. Application of diamond turned optics include laser resonator mirrors, x-ray microscopes, x-ray telescopes, missile optics, and scanner mirrors. The technology looks especially promising for present infrared requirements since both reflective, refractive, and transmittive components can be fabricated.

Diamond turning of optics can be defined as the use of a diamond tool on a precision lathe under very precisely controlled machine and environmental conditions to fabricate a finished optical component. The specific application of precision machining principles to diamond turning has been led by the Lawrence Livermore Laboratory (LLL), Livermore, California and Union Carbide Y-12 Plat (Y-12) Oak Ridge, Tennessee.

SAUNDERS, J.B.
"A SIMPLE INTERFEROMETRIC METHOD FOR WORKSHOP TESTING OF OPTICS"
Appl. Opt., 9, 1623 (1970)
A simple step-by-step method is given for deriving the shapes of wavefronts from data obtained with a wavefront shearing interferometer. No mathematics, other than arithmetic, is used. The result is the accurate deviation of the wavefront from a reference sphere that coincides with it at three chosen reference points. The method is intended primarily for the use of opticians in optical workshops, but is also quite practical for the final testing of optics for performance rating. A method is given by which an optician can evaluate an optical surface by comparing the interferogram produced by it and a known prism interferometer, with a drawing of the desired interferogram. This procedure is analogous to using test plates for visual inspection of optical surfaces.

SAWATARI, T.
"SURFACE FLAW DETECTION USING OBLIQUE ANGLE ILLUMINATION"
Appl. Opt., 11, 1337 (1972)

An analysis of a surface flaw detection method is presented in which oblique illumination is combined with a high pass spatial filter to detect the light scattered from surface flaws. The effects of surface finishes of test samples (meteoric plates) are assessed statistically, and the sensitivity of the system is calculated. Data have been collected on diffraction patterns and surface scratch detection for three stainless steel plates having different surface finishes. The results agree with theoretical consideration and are quite promising.

SAWATARI, T., KEATING, P.N., and ZIPIN, R.B.
"EXPERIMENTAL ANALYSIS OF SURFACE FLAW DETECTION USING GAZING ANGLE ILLUMINATION"
Appl. Opt., 12, 2598 (1973)

The capability of a method using grazing angle illumination for automated surface flaw detection has been analyzed experimentally for actual flaws. Bearing rolls were chosen as test samples and two different methods, low angle scattered light observation and high angle scattered light observation, were evaluated. For the latter method, an analysis of the data from a number of samples results in a sample classification that accurately matches that determined by careful visual inspection.

SAXENA, A.K.
"QUANTITATIVE TEST FOR CONCAVE ASPHERIC SURFACES USING A BABINET COMPENSATOR"
Appl. Opt., 18, 2897 (1979)

A quantitative test for the evaluation of surface figures of concave aspheric surface using a Babinet compensator is reported. A theoretical estimate of the sensitivity is 0.002 lambda for a minimum detectable phase change of 2 pi x 10^{-3} rad over a segment length of 1.0 cm.

SCHEELE, S.R.
"SCATTERING CHARACTERISTICS OF MIRRORS AND THE ASSOCIATED INVERSE SCATTERING PROBLEM"
Ph.D. dissertation, University of California at Los Angeles (1973)

No abstract provided.

SCHULZ, G. and SCHWIDER, J.
"PRECISE MEASUREMENT OF PLANENESS"
Appl. Opt., 6, 1077 (1967)

Interference methods are reviewed--particularly those developed at the German Academy of Sciences in Berlin--with which the deviations of an optically flat surface from the ideal plane can be measured with a high degree of exactness. One aid to achieve this is the relative methods which measure the differences in planeness between two surfaces. These are then used in the absolute methods which determine the absolute planeness of a surface. This absolute determination can be effected in connection with a liquid surface, or (as done by the authors) only by suitable evaluation of relative measurements between unknown plates in various positional combinations. Experimental, one using two- or multiple-beam interference fringes of equal thickness or of equal inclination. The fringes are observed visually, canned, or photographed, and in part several wavelengths or curves of equal density (Aquidensiten) are employed. The survery also brings the following new methods: a relative method, where, with the aid of fringes of superposition, the fringe separation is subdivided equidistantly thus achieving an increase of measuring precision, and an absolute method which determines the deviations of a surface from ideal planeness along arbitrary central sections, without a liquid surface, from four relative interference photographs.

SINGH, K. and BHATNAGAR, G.S.
"SPARROW LIMIT OF SPECTRAL RESOLUTION IN THE REFLECTION ECHELON AND THE FABRY-PEROT INTERFEROMETER HAVING SURFACE IMPERFECTIONS"
Appl. Opt., 9, 2326 (1970)
The limit of spectral resolution as defined by Sparrow has been calculated for the reflection echelon and Fabry-Perot interferometer having a different type of polishing imperfections on the surface of the plates. For the sake of comparison the Rayleigh limit of resolution has laso been calculated and compared with the Sparrow limit.

SLADKY, R.E. and DEAN, R.H.
"OPTICAL MEASUREMENT OF SURFACE QUALITY AND FIGURE OF DIAMOND-TURNED MIRRORS"
Union Carbide Corporation, Oak Ridge, Tennessee, Y-DA-6328 (1975)
No abstract provided.

SLADKY, R.E.
"SURFACE - FINISH MEASUREMENT WITH INTERFERENCE MICROSCOPES"
Oak Ridge Y-12 Plant, Tennessee (1977)
No abstract provided.

SOLLID, J.E. and SLADKY, R.E.
"EVALUATION OF SIGNLE-POINT DIAMOND-TURNED COPPER MIRRORS FOR THE LOS ALAMOS SCIENTIFIC LABORATORY EIGHT-BEAM CO_2 LASER: HELIOS"
This paper describes the best large-aperture single-point diamond-turned copper mirrors currently available. The state-of-the-art is progressing rapidly. At present, for 400-mm diam, f/16.5 spherical surfaces, the peak-to-valley figure can be held to two visible fringes in a center opf curvature test, and the surface roughness is better than 50 nm peak-to-valley.

Since the time of Galileo attempts have been made to machine optical components. With very few exceptions these attempts have failed. Recently, however, much careful attention has been paid to the numerous fine details such as vibration isolation, uniformity of spindle and tool drive, temperature control, tool sharpness, etc. Components of infrared quality are being produced in large numbers. The advantages of machined optics are a generally lower price, a higher production rate, a higher damage threshold (on the order of 11 J/cm^2, the intrinsic limit, for 1-ns, 10 micrometer pulses), and greater resistance to corrosion and tarnishing than can be achieved through conventional optical production. It is the combination of these advantages which made single-point diamond-turned (SPDT) optical components a key element in the current and projected Los Alamos Scientific Laboratory (LASL) CO_2 laser systems. There are two operating large pulsed CO_2 lasers at LASL; the TBS or Two-Beam System, and Helios, the Eight-Beam System. Helios has a nominal energy of 10kJ at 1 ns, while the TBS has a nominal energy of 2.5 kJ at 1 ns. The Antares CO_2 laser at LASL will have an energy of 10^5 J in 1 ns and consist of 6 beams of 12 segments, each of which is essentially an independent beam train. In addition to numerous smaller optics, a single segment of the beam train will contain the nine elements with a characteristic diameter of 40 cm or larger. There will be 72 such beam trains and 1500 elements. Completion of the laser is scheduled for 1982. Timely and reliable fabrication will be essential. Thus, single-point diamond turning forms an integral part of the CO_2 laser fusion effort.

SPRAGUE, R.A.
"SURFACE ROUGHNESS MEASUREMENT USING WHITE LIGHT SPECKLE"
Appl. Opt., 11, 2811 (1972)
No abstract provided.

SPRAGUE, R.A.
"OPTICAL DEVICE FOR MEASURING SURFACE ROUGHNESS"
Appl. Opt., 15, 8 (1974)
Bob Sprague shows us that the light scattered at a surface can be used to gauge the roughness. He gets good results by measuring the speckle contrast using an arithmetic average but suggests that the "route mean square can also be used."

STOVER, J.C.
"CHARACTERIZATION OF SMOOTH MACHINED SURFACES BY LIGHT SCATTERING"
Appl. Opt. (1975)
No abstract provided.

SWYT, D.A.
"SURFACE FINISH, FRICTION AND WEAR: THE NEED FOR MORE THAN ONE PARAMETER"
NBS Internal Report 73-196 (1973)
Surface finish is most commonly described by an arithmetic average (AA) value, often coupled with a description of the process by which the surface is finally formed. Since the insensitivity of the AA parameter to the periodic nature of surface structure is well known, many supplmental "second" parameters have been suggested. This short paper gives an indication of the basis for the insensitivity of the AA parameter to periodic structure and considers briefly some "wavelength-conscious" parameters (e.g., average wavelength and correlation lengths) which may be useful in supplementing the basic AA value for a more complete description of surface finish.

TEAGUE, E.C.
"EVALUATION, REVISION AND APPLICATION OF THE NBS STYLUS/COMPUTER SYSTEM FOR SURFACE ROUGHNESS MEASUREMENT"
NBS Technical Note 902, NBSIR-75-927 (1976)

This report describes in detail the hardware and software used at NBS to implement on a stylus instrument/minicomputer system the process of calibrating the system with an interferometrically measured step and the calculation of important characterizations of surface profiles. The characterizations of a profile which may be calculated include the Arithmetic Average value, the mean square value, the amplitude density function, the autocorrelation function and the average wavelength. The report also includes a statistical evaluation, using empirical and analytical techniques, of the calibration procedure's long term stability.

THEOCARIS, P.S. and GDOUTOS, E.E.
"SURFACE TOPOGRAPHY BY CAUSTICS"
Appl. Opt., 15, 1629 (1976)

The optical method of caustics, initially developed for recording abrupt plate slopes created by singularities in elastic stress fields, we extended to incorporate the study of the general case of any type of surface. A universal technique, based on the general theory of caustics developed in this paper, was formulated to study the topography of any surface from its corresponding caustics obtained by illuminating the surface by a parallel, convergent, or divergent light beam. The special case of an axisymmetric mirror with elliptical cross section, whose ellipticity varies from zero to infinity, was studied extensively to show the potentialities of the technique developed. It was shown that the caustics obtained are very sensitive to the particular form of the surface considered. From the procedure developed in this paper it was concluded that the method of caustics can be successfully used to record the topography of any surface with large or infinitesimal slopes.

TIMMS, C
THE MEASUREMENT OF FINELY FINSIHED SURFACES BY OPTICAL INTERFERENCE"
J. Sci. Instrum., 22, 245 (1945)

No abstract provided.

VAN HEEL, A.C.S. and SIMONS, C.A.J.
"LENS AND SURFACE TESTING WITH COMPACT INTERFEROMETERS"
Appl. Opt., 6, 803 (1967)

Easily manufacturable components are assembled into compact modified Twyman-Green interferometers and an interference microscope with only one objective.

[illegible]RBENT, J.P.M.
"SIMPLE OPTICAL TEST FOR SURFACE QUALITY"
Laser Technol., 4, 155 (1972)

No abstract provided.

VERBUNT, J.P.M.
"SIMPLE OPTICAL INTERFERENCE METHOD FOR THE INSPECTION OF SOLID SURFACES"
Appl. Opt., 12, 1839 (1973)
Measuring methods based on optical interference are used to evaluate the surface roughness of solids. This article gives an example of a simple and accurate method.

VERBURNT, J.P.M.
"'DROPLET INTERFEROMETRY' FOR INVESTIGATING SMOOTH SURFACES"
Philips Tech. Rev., 33, 74 (1973)
No abstract provided.

WELFORD, W.T.
"OPTICAL ESTIMATION OF STATISTICS OF SURFACE ROUGHNESS FROM LIGHT SCATTERING MEASUREMENTS"
Opt. Quantum Electron., 9, 269 (1977)
No abstract provided.

WILLIAMS, D.H.
"THE PUBLIC HEALTH SIGNIFICANCE OF SURFACE MEASUREMENTS"
Industries Supply Association, Inc., NBSIR 75-927
3-A Sanitary Standards for dairy processing equipment provide criteria for the cleanability of product contact surfaces, and for produce protection. The fabrication section of a 3-A Standard requires that product contact surfaces be at least as smooth as a #4 mill finish porperly applied to stainless steel sheets.

YOUNG, M.
"SUMMARY OF CONFERENCE ON STANDARDS FOR SCATTERING FROM OPTICAL SURFACES"
Proc. SPIE, 181 (1979)
No abstract provided.

YOUNG, M.
"CONFERENCE ON OPTICAL SCATTERING STANDARDS"
National Bureau of Standards, Boulder, Colorado 80303
This paper is a report on a conference, Standards for Scattering from Optical Surfaces, that we held February 6 and 7 1979, at the National Bureau of Standards in Boulder, Colorado. Approximately 50 scientists attended and heard a dozen invited papers and a panel discussion. The visitors agreed, among other things, that national physical standards are neeeded. There was also general agreement that NBS should consider providing measurement services (such as well characterized surfaces) based on a state-of-the-art facility for precision scattering measurements and calibrations.

YOUNG, R.D.
"SURFACE MICROTOPOGRAPHY"
Phys. Today, 24, 43 (1971)

The growing field of surface science would benefit considerably from measurement of surface microtopography down to the atomic level. A brief review is presented of several instruments used to quantitatively characterize the surface microtopography of metallic surfaces. Techniques are discussed for employing the transmission electron microscope, the scanning electron microscope, the optical interference microscope and an engineering profile measuring instrument to measure surfaces suitable for surface science experiments. In addition to a new non-contacting instrument whch is presently under development will be described. It is concluded that several techniques are presently available for detecting single atom steps on single-crystal surfaces.

YOUNG, R.D., WARD, J., and SCIRE, F.
"THE TOPOGRAFINER: AN INSTRUMENT FOR MEASURING SURFACE MICROTOPOGRAPHY"
Review of Scien. Instru., 43, 999 (1972)

A noncontacting instrument for measuring the microtopography of metallic surface has been developed to the point where the feasibility of constructing a prototype instrument has been demonstrated. The resolution of the preprototype unit is 30 A perpendicular to the surface and 4000 A in the plane of the surface. Inherent noise in the perpendicular direction corresponds to 3 A, one atomic layer. By using a typical field emitter with radius of 100 A, an ultimate limit of 200 A would be expected for the horizontal resolution. Topographic maps of an infrared diffraction grating have been measured in order to demonstrate the performance of the instrument in measuring a well characterized surface. The instrument has been shown to conform to the Fowleer-Nordheim description of field emission while spaced at the usual operating distances for the surface. When moved to within 30A of the surfaces, its performance is compatible with Simmons' theory of MVM tunneling. In the MVM mode, the instrument is capable of performing a noncontacting measurement of the position of a surface to within about 3 A. The instrument can be used in surface science experiments to study the density of single and multiple atom steps on single crystal surfaces, adsorption of gases, and processes involving electronic excitations at surfaces.

YOUNG, R.D. and SCIRE, F.E.
"PRECISION REFERENCE SPECIMENS OF SURFACE ROUGHNESS:
SOME CHARACTERISTICS OF THE CALI-BLOCK
Jour. of Research of NBS, 76C (1972)

The distribution of Arithmetic Average values of surface roughness across the 120 and 20 microinch patches of NBS Cali-Block "B" have been measured. It is shown that each distribution can be described in terms of its mean values and standard deviation. The observed systematic distribution of AA values strongly suggests that the user select widely spaced regions at random on the patch when calibrating a roughness measuring instrument.

YOUNG, R.D.
"EIGHT TECHNIQUES FOR THE OPTICAL MEASUREMENT OF SURFACE ROUGHNESS"
NBS Internal Report 73-219 (1973)
No abstract provided.

YOUNG, R.D.
"EIGHT TECHNIQUES FOR THE OTPICAL MEASUREMENT OF SURFACE ROUGHNESS"
NBS Internal Report 73-219 (1973)
The need for a fast, on line, non-destructive techique for measuring surface roughness has recently accelerated the decade long development of optical methods. It is anticipated that these new techniques will add a new dimension to the surface roughness measurement system which may require an appropriate NBS response. In order to formulate this response, the eight optical techniques which have been identified are briefly described and are summarized and compated in Table 1.

It is concluded that model deficiencies, questionable theoretical bases, as well as physical and analytical limitations cast serious doubt on the present accuracy of these techniques for absolute measurements. Optical Techniques seem more suitable for comparison measurements, i.e., measurement after appropriate calibration using surfaces which have been measured using other techiques. Thus, it is concluded that the most appropriate NBS remeasured using other techniques.

YOUNG, R.D.
"ONE PRECISION ROUGHNESS STANDARD SPECIMEN NO. PG-1366"
NBS Internal Report 75-927 (1974)
No abstract provided.

YOUNG, R.P.
"METAL-OPTICS SCATTER MEASUREMENTS"
Arnold Engineering Development Center, Arnold Air Force Station, Tennessee 37389 (1975)
Many applications using metal optics require that the optical elements have very low scattering surfaces. A scatterometer suitable for measuring properties of metal mirror has been developed at AEDC. The scatterometer operates at two wavelengths, 0.6328 and 10.6 micrometers. Tests required to evaluate the performance of the scatterometer are described, and the directional scattering data off a high quality metal mirror are presented.

YOUNG, R.P.
"FACILITY COMPARISON MIRROR SCATTER MEASUREMENTS"
AEDC-TR-75 (to be published)
No abstract provided.

YOUNG, R.P.
"DEGRADATION OF LOW SCATTER MIRRORS BY PARTICLE CONTAMINATION"
AIAA Paper No. 75-667, presented at the AIAA 10th Thermophysics Conference at Denver, Colorado (1975)

No abstract provided.

ABDEL-AZIZ, Y.I.
"ASYMMETRICAL LENS DISTORTION"
Photogramm. Eng. and Remote Sensing, 41, 337 (1975)

In laboratory camera calibration, radial lens distortion is provided among four perpendicular diagonals in the image plane. According to Harris, Tewinkel and Whitten (1963) one can use this information to estimate the symmetrical lens distortion and the radial component of asymmetrical lens distortion. In the Harris-Tewinkel-Whitten model, the tangential component of asymmetrical lens distortion is considered to be non-existent (based mainly on the lack of data at that time). This article presents formulation by which symmetrical and asymmetrical (radial and tangential) lens distortion parameters can be estimated from the radial lens distortion along the four diagonals (3 Refs.).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTNG
Identifiers: LABORATORY CAMERA CALIBRATION; IMAGE PLANE; ASYMMETRICAL LENS DISTORTION

ADACHI, L., MASUDA, T., and NISHIYAMA, S.
"A TESTING OF OPTICAL MATERIALS BY THE TWYMAN TYPE INTERFEROMETER"
Naz. Ottica, 16, 666 (1961)

No abstract provided.

ADACHI, I., MASUDA, T., NAKATA, T. and NISHIYAMA, S.
"THE TESTING OF OPTICAL MATERIALS BY THE TWYMAN TYPE INTERFEROMETER III"
Naz. Ottica, 17, 319 (1962)

No abstract provided.

ASHTON, A. and MARCHANT, A.C.
"NOTE ON THE TESTING OF LARGE GLASS PANELS"
Opt. Acta, 14, 203 (1967)

No abstract provided.

BACK, F.G.
"DESIGN CONSIDERATION FOR INTERMEDIATE AND FAR INFRARED OPTICS"
Soc. Photo-Optical Instrumentation Engineers, 67, 7 (1975)

Deals with the optical design for the infrared region. The problems of different materials for the various IR regions are discussed, taking into consideration the refraction dispersion and absorption losses, as well as the material deficiencies. Ways of measurement and the varying testing methods are analyzed. In addition to the basic optics, the Zoomar orbiter and two Zoomar IR lenses are described (2 Refs.).

Descriptors: OPTICAL MATERIALS; OPTICAL TESTING; OPTICAL DESIGN TECHNIQUES; PHOTOGRAPHIC LENSES
Identifiers: FAR INFRARED OPTICS; OPTICAL DESIGN;

MATERIALS; ABSORPTION LOSSES; TESTING
METHODS; ZOOMAR ORBITER; ZOOMAR IR
LENSES; REFRACTION LOSS; DISPERSION LOSS;
INTERMEDIATE IR OPTICS

BENDON, B. and GIANINO, P.D.
"OPTICAL PERFORMANCE EVALUATION OF INFRARED TRANSMITTING MATERIALS"
J. Electron. Mater. 2, 87 (1973)

A non-uniform laser beam traversing a material sample undergoes thermal lensing due to thermaly induced changes in refractive index and bulging of sample faces. Vector Kirchhoff diffraction theory is applied to provide a detailed picture of the transmitted beam properties in the presence of lensing. In particular, the time evolution of the focal properties and the intensity degradation are investigated. The calculations account for birefringence due to thermally-induced stress, which is shown to play a major role in the alkali halides. The optical performance of transmitting materials in various time regimes is evaluated for Gaussian beams incident on thin circular samples. It is found that at 10.6mum alkali halides, such as KCL and KBR, substantially outperform semiconductors, such as CDTE and GE, which in turn outperform various glasses (11 Refs)

Descriptors: LASER ACCESSORIES; REFRACTIVE INDEX; OPTICAL MATERIALS; BIREFRINGENCE

Identifiers: OPTICAL PERFORMANCE EVALUATION; INFRARED TRANSMITTING MATERIALS; LASER BEAM; THERMAL LENSING; REFRACTIVE INDEX; BULGING; VECTOR KIRCHHOFF DIFFRACTION THEORY; TIME EVOLUTION; FOCAL PROPERTIES; INTENSITY DEGRADATION; BIREFRINGENCE; ALKALI HALIDES; GAUSSIAN BEAMS; KCL; KBR; CDTE; GE; GLASSES; THERMALLY INDUCED STRESS

CHIANG, F.P. and SLEPETZ, J.M.
"CRACK LENGTH MEASUREMENT IN COMPOSITES"
J. of Composite Materials, 8, 134 (1973)

No abstract provided.

DE VANY, A.S.
"A NOTE ON TESTING HOMOGENEITY OF GLASS"
Appl. Opt., 3, 643 (1963)

No abstract provided.

DE VANY, A.S
"AN INSTRUMENT FOR MEASURING STRAIN AND HOMOGENEITY IN GLASS"
Appl. Opt., 4, 513 (1964)

No abstract provided.

DE VANY, A.S.
"SUPPLEMENT TO: AN INSTRUMENT FOR MEASURING STRAIN AND HOMOGENEITY IN GLASS"
Appl. Opt., 4, 756 (1965)
No abstract provided.

DE VANY, A.S.
"USING A MURTY INTERFEROMETER FOR TESTING THE HOMOGENEITY OF TEST SAMPLES OF OPTICAL MATERIALS"
Appl. Opt. 10, 1459 (1971)
No abstract provided.

EVANS, R.W., GALLAGHER, P., and RIMMER, D.A.
"THE DESIGN AND CONSTRUCTION OF A LARGE APERTURE OPTICAL SYSTEM USING HOLOGRAPHIC AND INTERFEROMETRIC TESTNG TECHNIQUES"
Opt. and Laser Technol, 7, 203 (1975)
In the design and construction of a large aperture optical system problems were encountered in figuring the optica elements and in mountng them to achieve mechanical stability. The various optical tests which were used to help overcome these problems on a system comprising refracting, reflecting, and mangin elements are described. Test plates, star tests, OTF, Twyman-Green, and holographic techniques were all used at some stage, and the application for which each was used and the reasons why it was considered the most suitable technique are discussed (7 Refs.).
Descriptors: OPTICAL DESIGN TECHNIQUES; LENSES; OPTICAL INSTRUMENT TESTING; HOLOGRAPHY; LIGHT INTERFEROMETRY;
Identifiers: DESIGN; CONSTRUCTION; LARGE APERTURE OPTICAL SYSTEM; INTERFEROMETRIC TESTNG TECHNIQUES; OPTICAL ELEMENTS; MOUNTING; MECHANICAL STABILITY; OPTICAL TESTS; MANGIN ELEMENTS; STAR TESTS; OTF; HALOGRAPHIC TECHNIQUES; REFRACTING ELEMENTS; REFLECTING ELEMENTS; TEST PLATES; TWYMAN GREEN TECHNIQUE

FELDMAN, A.F.
"MEASUREMENT OF THE PHOTOELASTIC CONTENTS OF OPTICAL MATERIALS"
Opt. Eng., 17, 453 (1978)
The photoelastic constants describe the effect of stress or strain on the refractive indices of materials. These coefficients are important in several applications. They are required for the computation of stress-induced optical distortion in optical systems such as high-power laser systems and they are needed for computing figures of merit for materials to be used in cousto-optic devices. Interferometric and polarimetric techniques are described for measuring piezo-optic coefficients under static loading conditions. Acousto- optic and Brillouin scattering techniques are described for measuring elasto-optic constants.

FIZEAU, H.
"RECHERCHES SUR LES MODIFICATIONS QUE SUBIT LA VITESSE DE LA LUMIERE DANS LA VERRE ET PLUSIEURS AUTRES CORPS SOLIDES SOUS L'INTERFERENCE DE LA CHALEUR"
(RESEARCH ON THE MODIFICATIONS THAT THE SPEED OF LIGHT SUFFERS IN GLASS AND SEVERAL OTHER SOLID BODIES UNDER THE INFLUENCE OF HEAT).
C.R. Acad. Sci., 54, 1237 (1862)
No abstract provided.

FORMAN, P.F.
"A NOTE ON POSSIBLE ERRORS DUE TO THICKNESS VARIATIONS IN TESTING NOMINALLY PARALLEL PLATES"
Appl. Opt., 3, 646 (1964)
No abstract provided.

FRANCON, M. and WAGNER, D.
"ETUDE DES DEFAUTS D'HOMOGENEITE PAR LA METHODE DE L'OMBRE PORTEE"
(STUDY OF HOMOGENEITY DEFECTS BY THE CARRIED SHADOW METHOD).
C.R. Acad. Sci., 230 1850 (1950)
No abstract provided.

HAIG, N.D.
"TRANSVERSE RAY ABERRATION MEASUREMENT AT 10.6 MICRONS"
Soc. Photo-Optica Instrumentation Eng. (1974)
The problem of OTF measurement in the far IR is discussed in terms of lens testing methods. The use of a line spread function scanner is described (7 Refs.).
Descriptors: INFRARED IMAGING; LENSES; OPTICAL INSTRUMENT TESTING; OPTICAL IMAGES; TRANSFER FUNCTIONS; ABERRATIONS
Identifiers: 10.6 MICRONS; FAR IR; LENS TESTING; LINE SPREAD FUNCTION SCANNER; OPTICAL TRANSFER FUNCTION; TRANSVERSE RAY ABERRATION

HALE, G.E.
"A METHOD OF TESTING OPTICAL GLASS"
Publ. Astron. Soc. Pac., 24, 107 (1912))
No abstract provided.

HARIHARAN, P. and SEN, D.
"TRIANGULAR PTH MACROINTERFEROMETER"
J. Opt. Soc. Am., 49, 1105 (1959)
No abstract provided.

KRYNIN, L.I.
"PROBABILITY ANALYSIS OF THE CENTERING ACCURACY IN COMMERCIALLY MANUFACTURED OBJECTIVES"
Sov. J. Opt. Technol., 44 664 (1977)

A method is described for calculating the allowable deviations of optical elements in the construction of serially and mass produced objectives. Formulas are given for calculating the decentering of the lenses (8 Refs.).

Descriptors: LENSES; OPTICAL TESTING
Identifiers: COMMERCIALLY MAUFACTURED OBJECTIVES; OPTICAL ELEMENTS; PROBABILITY ANALYSIS; CENTRING ACCURACY; LENS DECENTRING

KUHNE, C.
"PRODUCTION AND TESTING OF THE OPTICAL ELEMENTS OF THE FIRST 2.2 M-TELESCOPE FOR MPIA"
Astron. and Astrophys., 41, 345 (1975)

Describes the first two 2.2-m telescopes for the Max Planck-Institute of German-Spanish Astronomical Center on Calar Alto, Province Almeria. It was found that the two-mirror systems of the completed telescope give reason to expect a concentration of Hartman test points of intersection of 96 percent at 0.3 ARCSEC DIA., and 100 percent at 0.6 ARCSEC DIA from the residual production errors alone (3 Refs.).

Descriptors: ASTRONOMICAL TELESCOPES; OPTICAL INSTRUMENT TESTING; OPTICAL WORKSHOP TECHNIQUES
Identifiers: TESTING; 2.2 M-TELESCOPE; HARTMAN TEST; RESIDUAL PRODUCTION ERRORS; OPTICAL ELEMENTS PRODUCTION; CORRECTION LENS; RITCHEY CHRETIEN TELESCOPE; INTERSECTION POINTS

LAGENBECK, P.
"MULTIPASS TWYMAN-GREEN INTERFEROMETER"
Appl. Opt., 6, 1425 (1967)

No abstract provided.

LIDWELL, M.O.
"PRODUCTION TESTS FOR INFRARED LENSES"
Soc. Photo-Optical Instrumentation Eng. (1977)

Inhomogeneity in an optical material can generally be observed at any wavelength for which the material will transmit radiation. For infra-red materials with no visual transmission. Useful tests can be performed using a vidicon sensitive to radiation of up to 2 microns The CO/sub 2/ laser though difficult to use for interfrometry is ideal for simple transmission measurements. The MTF which is generally accepted as a standard for imaging performance can be determined from spread functions which can be measured with simple although necessarily well engineered equipment. Standards for homogeneity of materials however need to be established to allow the system manufacturer to select suitable material. It is desirable to refine the methods described to provide adequate tests for systems of diffraction limited performance (7

Refs.).
Descriptors: OPTICAL TESTING; LIGHT TRANSMISSION; OPTICAL TRANSFER FUNCTION; LENSES
Identifiers: INFRARED LENSES; SIMPLE TRANSMISSION MEASUREMENTS; MTF; SPREAD FUNCTIONS; DIFFRACTION LIMITED PERFORMANCE; PRODUCTION TESTS; INHOMOGENEITY

LOHMANN, A. and BRYNGDAHL, O.
"A LATERAL WAVEFRONT SHEARNG INTERFEROMETER WITH VARIABLE SHEAR"
Appl. Opt., 6, 1934 (1967)
No abstract provided.

LYTLE, J.D.
"SPECIFYING GLASS AND PLASTIC OPTICS - WHAT'S THE DIFFERENCE"
M. U. Engineering & Manufacturing, Inc. (1979)
Plastic optics have come a long way since the first lens was injection molded many years ago;

in fact today, the replacement of conventional optical components seems to be one of the least exciting aspects of polymer optics. Like waveguide optics, holographic optics, and coherent optics, plastic optics offers freedoms and options simply not available in conventional glass optics. This is not to say that plastic is not well suited to substituting for glass in many ordinary applications. The real virtues of plastic become clear, however, when one takes advantage of the medium to produce a totally unconventional component. Fig. 1 depicts a precision polygon having internal facets - a part whose manufacture is not possible using conventional glassworking techniques.

MASUDA, T., NISHIYAMA, S., NAKATA, T., and ADACHI, I.
"THE TESTING OF OPTICAL MATERIALS BY THE TWYMAN TYPE INTERFEROMETER II"
Atti Fond. Giorgio Ronchi Contrib. Ist. Naz. Ottica, 17, 197 (1962)
No abstract provided.

MURTY, M.V.R.K.
"A NOTE ON THE TESTING OF HOMOGENEITY OF LARGE-APERTURE PARALLEL PLATES OF GLASS"
Appl. Opt., 2, 1337 (1963)
No abstract provided.

MURTY, M.V.R.K.
"ADDENDUM TO: A NOTE ON THE TESTING OF HOMOGENEITY OF LARGE APERTURE PARALLEL PLATES OF GLASS"
Appl. Opt., 3, 704 (1964)
No abstract provided.

PARKS, R.E., SUMNER, R.E., and STRITTMATTER, R.E.
"POLISHING SINGLE POINT DIAMOND TURNED MIRRORS"
OSA, San Mateo (1977)

A method of removing the high frequency microripple from single point diamond machined mirrors has been developed. The process uses conventional hand polishing techniques and laps of sufficient rigidity to bridge the microripple yet soft enough not to scratch the metal mirror surface. Substantial material must be removed from the mirror surfaces in some cases and the surface figure may be degraded unless careful testing is done during the process. We present photographs showing the reduction in scattering and improvement in mirror surface roughness as the result of the polishing. Phase-contrast microphotographs also show that the polished surface is almost as free of mechanical defects (scratches and pits) as the orignal virgin turned metal surface.

PRINCIPE, V.P.
"LENS TEST FACILITY"
Soc. Photo-Optical Instrumention Eng. (1971)

This facility calibrates the MIPIR radar boresight lenses (versatel) by measuring systematic deviations of the versatel lens that result from gravitational effects on the lens at different elevation angles. The versatel lens is mounted on a rotatable test bed installed in an insulated, temperature-controlled room. The test bed can be rotated up to 360 degrees and can simulate the different elevation angles a radar would have during operations. Static testing of the versatel lens is accomplished by measuring the optical axis deviations (azimuth and elevation) that result when the test bed is positioned at different elevation settings. These tests can be repeated to different ambient temperatures.

Descriptors: OPTICAL INSTRUMENTS TESTING; LENSES

Identifiers: LENS TEST FACILITY; CALIBRATES; MIPAR RADAR BORESIGNT LENSES; SYSTEMATIC DEVIATIONS; VERSATEL LENS; GRAVITATIONAL EFFECTS; ELEVATION ANGLES; ROTATABLE TEST BED; RADAR; OPTICAL AXIS DEVIATIONS

REITMAYER, F. and SCHUSTER, E.
"HOMOGENEITY OF OPTICAL GLASSES"
Appl. Opt., 11, 1107 (1972)

No abstract provided.

ROBERTS, F.E. and LANGENBECK, P.
"HOMOGENEITY EVALUATON OF VERY LARGE DISKS"
Appl. Opt., 8, 2311 (1969)

No abstract provided.

SAUL, R.S. and WILLIAMS, T.L.
"AN INFRA-RED INHOMOGENEITY SCANNER"
Opt. Acta, 25, 1149 (1978)

Various techniques for measuring the homogeneity of blanks of infra-red transmitting materials have been studied. These studies showed that a sample pupil scan technique. Using a narrow collimated beam of radiation and a detector system capable of measuring angular deflections of the beam produced by inhomogeneities, was very sensitive. An instrument based on this technique has been constructed. It scans the sample automatically, accommodates blanks up to 200 mm in diameter and plots out information in the form of a pseudo-three dimensional homogeneity map of the sample (2 Refs.).

Descriptors: LIGHT TRANSMISSION; OPTICAL MATERIALS; LENSES; OPTICAL TESTING

Identifiers: BLANKS; TRANSMITTING MATERIALS; SIMPLE PUPIL SCAN TECHNIQUE; NARROW COLLIMATED BEAM; RADIATION DETECTOR SYSTEM; ANGULAR DEFLECTIONS; IR INHOMOGENEITY SCANNER

SIDDIQUI, I.M. and SMITH, R.W.
"A HOLOGRAPHIC INTERFEROMETER FOR INVESTIGATING THE HOMOGENEITY OF OPTICAL GLASS"
Blackett Laboratory, Imperial College, England (1978)

The design of a holographic interferometer for investigating the homogeneity of optical glass is discussed. It is shown that the interferometer can be used to determine very quickly linear variations in the refractive index of glass samples. Measurements of the non-linear variation in index are discussed and examples given. Modification of the instrument to make it a multiple pass interferometer is briefly described.

SLEPETZ, J.M., ZAKAESKI, T.F., and NOVELLO, R.F.
"IN-PLANE SHEAR TEST FOR COMPOSITE MATERIALS"
Army Materials and Mechanics Research Center, Tech. Rpt. 78-30 (1978)

No abstract provided.

SYNBORSKI, C.E.
"FURTHER INVESTIGATIONS OF THE HOMOGENEITY OF INDEX REFRACTION IN UNIMAG GLASS"
Optical Shop Notebook, IX, 126 (1975)

No abstract provided.

TWYMAN, F. and DALLADAY, A.J.
"VARIATION IN REFRACTIVE INDEX NEAR THE SURFACES OF GLASS MELTS"
Trans. Opt. Soc., 23, 131 (1921)

No abstract provided.

WEBER, M.J., MILAN, D., and SMITH, W.L.
"NONLINEAR REFRACTIVE INDEX OF GLASSES AND CRYSTALS"
Opt. Eng., 17, 463 (1978)

The propagation of intense optical beams through dielectric media induces changes in the refractive index which cause self focusing and beam breakup in high-power laser systems. After a brief discussion of the origin and spatial anisotropy of refractive-index coefficient are reviewed. The use of time-resolved interferometry is described in detail. Nonlinear indices for optical glasses and crystals measured at 1064 nm by this technique are tabulated. From these data, an empirical expression is given which, using the linear refractive index and partial dispersion, provides a good estimate of the nonlinear index of optical materials inn the long-wavelength limit.

WILLIAMS, T.L.
"TESTING OF OPTICAL COMPONENTS FOR THERMAL IMAGING SYSTEMS"
Laser 77 Opto-Electronics 234 (1977)

The use of transmission optics in thermal imaging systems has created a need for special test instruments working in 3 to 5 mum and 8 to 14 mum atmospheric windows. The author describes briefly a number of instruments developed for this purpose and includes a CO/Sub 2/ laser interferometer for measuring the homogeneity of lens blanks and the wavefront aberrations of complete lens systems. Instruments for measuring MTF, LSF and axial transmission. And finally a scanning gauge for checking the aspheric surfaces now commonly used in thermal imaging optics (7 Refs)

Descriptors: INFRARED IMAGING; LENSES; LASER BEAM APPLICATIONS; ABERRATIONS; OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; OPTICAL SYSTEMS

Identifiers: THERMAL IMAGING SYSTEMS; TRANSMISSION OPTICS; TEST INSTRUMENTS; CO/SUB 2/ LASER INTERFEROMETER; HOMOGENEITY; LENS BLANKS; WAVEFRONT ABERRATIONS; COMPLETE LENS SYSTEMS; MTF; LSF; AXIAL TRANSMISSION; SCANNING GAUGE; ASPHERIC SURFACES; OPTICAL COMPONENTS TESTING

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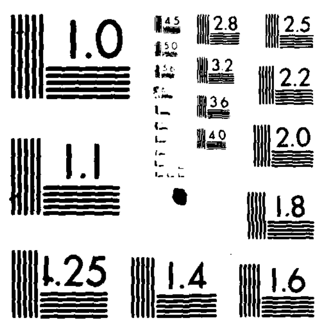

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

18 MISCELLANEOUS

ADACHI, P. and ISHIKI, M.
"DESIGN AND TESTING INTERFACE OF A JAPANESE SINGLE-LENS REFLEX CAMERA"
J. Opt. Soc., Am., 63, 1274 (1973)

The recent developments in laser technology have influenced the in-process testing of lens manufacturing, as well as the evaluation of lens aberration. In particular, ion lasers combined with electronic devices will revolutionize this area. Better zoom lenses and conversion-type designs.

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTING; OPTICAL DESIGN TECHNIQUES;
Identifiers: DESIGN; TESTING; LASER TECHNOLOGY; JAPANESE SINGLE LENS REFLEX CAMERA

AMON, G.
"OPTICAL INTERFEROMETER"
App. Opt., 17, 1474 (9177)

This interferometer consists of a cube with three beam-splitting faces S_1, S_2, and S_3. A light beam from a laser 1 is split at S_2 and recombined to interfere at detector D_1. Further splitting occurs at S_1, S_2, and S_3 so that four interference signals are obtained altogether at detectors D_1, D_2, D_3, and D_4. Signals at $D_1$and D_2 are 90^o out of phase, as are signals at D_3 and D_4. These phase shifts allow a unique determination of length variations in both directions.

D.C. APPLEBAUM, D.R. GRIESER, J.W. BEAL, H.M. EPSTEIN, and P.J. MALLOZZI
"'REAL-TIME' DIAGNOSTICS FOR A LASER FUSION SYSTEM"
Opt. Eng., 15, 29 (1976)

An automated diagnostic system has been developed and installed on a multibeamlaser for fusion research. Laser-beam phase and intensity profile, focal-spot profile, pulse width, beam energy, and other laser parameters are measured at a number of points in the system. Data from the optical and voltage sensing elements are processed by an on-line minicomputer and the information is presented in graphic, pictorial, and tabular form. The processed information is used for system performance evaluation and experimental planning on a real-time basis.

ARTISHEVSKII, V.I. and GRADOBOEV, V.M.
"STANDARD TARGETS FOR DETERMINING THE PHOTOGRAPHIC RESOLUTION OF OBJECTIVE LENSES"
Sov. J. Opt. Tech., 42, 672 (1975)

The following targets are compared critically ' Soviet bar, Soviet radial, USAF three-bar, Canadian bar, Japanese bar, Polish ring,British 'spiral', British bar, French bar, and Indian bar. Consideration is based on choice of target background and on configuration of target elements and groups. It is concluded that different targets should be used for testing of mass-produced lenses and for detailed studies on experimental lenses (6 Refs.).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL RESOLVING POWER;

Identifiers: OPTICAL TESTING; REVIEWS; PHOTOGRAPHIC RESOLUTION; OBJECTIVE LENSES; TESTING; STANDARD TARGETS; MASS PRODUCED LENSES

BAJUK, D.
"A HIGH ACCURACY SURFACE CONTOUR MEASURING MACHINE"
A surface contour measuring machine is described which can measure general aspheric or axi-symmetric aspheric surfaces repeatably to .000005 inches or better in most cases. The computer system which controls the measuring machine and which performs the data analysis is discussed. Aspheric production applications are shown in which the measuring machine plays a vital role.

BAKER, L.R. and WILLIAMS, T.L.
"NEW ELECTRONIC WAVEFRONT PLOTTER"
Appl. Opt., 4, 285, (1965)
No abstract provided.

BARAKAT, R.
"GENERAL DIFFRACTION THEORY OF OPTICAL ABERRATION TESTS, FROM THE POINT VIEW OF SPATIAL FILTERING"
J. Opt. Soc. Am., 59, 1432 (1969)
No abstract provided.

BEAVERS, W.I. and SWIFT, W.D.
"PHOTOELECTRIC FRINGE STRENGTH MEASUREMENT"
Appl. Opt., 7, 1975 (1968)
Experiments in photoelectric measurement of interference fringe strengths by means of a scanning photometer are described. The observed performance of the system is compared with the theoretical prediction for such a configuration. Signal-to-noise ratio variation and turbulance effects are studied. A high precision measurement of source angular diameter with this technique is demonstrated.

BEEVERS, J.C.
"NATIONAL STANDARDS ORGANIZATIONS AND OPTICAL DRAWING PRACTICE"
Zygo Corporation, Middlefield, Connecticut 06455 (1979)
In the practice of engineering, standards affect the communication of ideas and descriptions of items. Standards can be individually set, contractually defined, or set by industrial and professional organizations. This paper presents the role that the American National Standards Institute plays in developing an optical drawing practice standard.

BENTON, S.A. and MERRILL, D.P.
"SIMPLIFIED TALBOT INTERFEROMETERS FOR LENS TESTING"
Opt. Eng., 15, 328 (1976)
Moire fringes and the Talbot self-imaging effect can be combined to produce

shearing-interferometric-like maps of lens refractive power with high sensitivity and accuracy. Here we explore the properties of a simplified interferometer, consisting of a white-light source and two dissimilar gratings, designed to be rugged enough for field testing of sunglass lenses.

BIRCH, K.G.
"A MODIFIED MEASURING PROJECTOR FOR THE EVALUATION OF INTERFEROGRAMS"
Opt. Acta, 19, 615 (1972)
No abstract provided.

BRIERS, J.D.
"INTERFEROMETRIC FLATNESS TESTING OF NONOPTICAL SURFACES"
Appl. Opt., 10, 519 (1971)
No abstract provided.

BROOKS, R.E. HEFLINGER, L.O., and WUERKER, R.F.
"HOLOGRAPHIC RECORDING VIA THREE-LEVEL SOLID STATE LASER MATERIAL"
App. Opt., 10, 2000 (1970)
A holographic apparatus is described which uses a solid state three-level laser as the source of coherent light. The recording plate is made from the same type of three-level laser material used to make the solid state laser. The plate provides a temporary recording of the hologram, the retention time of which is determined by the fluorescent lifetime of the material itself.

BROT, J.M., OLIVIE, M., CHARLOT, A., CORNO, J., LAMARE, M., and SIMON, J. "INTERFEROMETER FOR THE CONTROL OF INFRA-RED MATERIAL AND THE EVALUATION OF INFRA-RED LENSES AT 10 MUM"
Laser International '76 UK, 146 (1976)
This new type of interferometer utilizes a diffraction grating as a beam divider and permits an important variation in the fringe contrast to be obtained for a given blaze angle by variation of the efficacy of the grating with the orientation of the plane of polarization or by variation of transmittance of the path of measurement. This improvement permits the compensation of photometric losses due to either an absorbing material or a highly reflecting material that may be under test. In this way, it is possible to evaluate all materials within a 10-100 percent transmission range (3 Refs.).
Descriptors: LIGHT INTERFEROMETERS; DIFFRACTION GRATINGS; ASPHERICAL LENSES; EVALUATION; OPTICAL TESTING; INTRARED IMAGING
Identifiers; EVALUATION; INTERFEROMETER; DIFFRACTION GRATING; BEAM DIVIDER; FRINGE CONTRAST; BLAZE ANGLE; PHOTOMETRIC LOSSES; IR MATERIALS; IR LENSES; 10.6 MICRONS

BUBIS, I. YA. and KRASIN, V.S.
"A METHOD INSPECTING THE LARGE LENSES OF AN ASTRONOMICAL OBJECTIVE IN TRANSMITTED LIGHT"
Sov. J. Opt. Tech., 40, 67 (1973)
The precise measurement of the large spherical aberrations of astronomical components by an imposed slit-and-filament method (defocused gratingmethod) is described (2 Refs.).
Descriptors: ASTRONOMICAL TELESCOPES; LENSES; OPTICAL TESTING;
Identifiers: INSPECTION METHOD; SLIT FILAMENT METHOD; LARGE LENSES; ASTRONOMICAL OBJECTIVE; TRANSMITTED LIGHT; SPHERICAL ABERRATIONS; DEFOCUSED GRATING METHOD

CASASENT, D. and LUU, T.
"PERFORMANCE MEASUREMENT TECHNIQUES FOR SIMPLE FOURIER TRANSFORM LENSES"
Appl. Opt., 17, 2973 (1978)
The use of simple off-the-shelf lenses as Fourier transform elements in an optical computer is considered. Several schemes for measuring those lens parameters that determine the performance of such simple lenses as Fourier transform elements are provided with emphasis on lens phase errors. It is assumed that no lens design data are available for the lens under test.

CHESHIRE, F.J.
"NOTE ON EYEPIECE FOR TESTING THE SQUARING ON OF TELESCOPE OBJECT GLASSES"
Trans. Opt. Soc., 22, 235 (1920)
No abstract provided.

CLOUD, G.
"SLOTTED APERTURES FOR MULTIPLYING GRATING FREQUENCIES AND SHARPENING FRINGE PATTERNSIN MOIRE PHOTOGRAPHY"
Opt. Eng., 15, 578 (1976)
Slotted aperture filter masks can be used to "tune" a photographic system to an integral multiple of a fundamental grating frequency. Such a procedure can be used in moire photography for multiplying sensitivity and for obtaining improved rendering of fringe patterns. Depth of field is increased, and a camera lens of poorer quality than is normally required for high resolution photography of moire gratings is adequate. Also gained is flexibility in optical data processing of moire photographs and in the use of two-dimensional grid and dot specimen arrays.

CRANE, R.
"INTERFERENCE PHASE MEASUREMENT"
Appl. Opt., 8, 538 (1969)
No abstract provided.

DE VANY, A.S.
"A UNIVERSAL TESTER"
Appl. Opt., 5, 867 (1966)
No abstract provided.

DE VANY, A.S.
"THE SLUMPING OF OPTICAL SURFACES DURING COATING"
App. Opt., 5, 735 (1966)
Slumping of optical surfaces takes place while antireflection subtrates are being coated at 205°C. Greater slumping is experienced at higher temperatures. Optical glasses held in kinetic-designed holders exhibit variable memories of reslumping. Glass elements held in nonkinetic and kinetic holders are compared at 205°C.

DE VANY, A.S.
"SUPPLEMENT TO: SOME ASPECTS OF INTERFEROMETER TESTING AND OPTICAL FIGURING"
App. Opt., 9, 1219 (1969)
No abstract provided.

DODD, J.G.
"INTERFEROMETRY WITH SCHLIEREN MICROSCOPY"
App. Opt., 16, 470 (1977)
It is demonstrated theoretically that if the stopin a schlieren system is no larger than the central maximum of the empty field Airy disk at the stop location, the system will behave as an interferometer for objects much smaller than the empty field. Interferograms produced by such a system are shown.

DODGEN, D.
"TESTING OF CONVEX PARABOLOIDS"
Opt. Eng., 14, 525 (1975)
An optical test method for determining the optical quality of convex paraboloidal surfaces is described. Several testmethods are described briefly; however, the optimum method usuing a collimator-reflector is described in more detail.

EICHLER, W. and HAFERKORN, H.
"THE CALCULATION OF THE POLYCHROMATIC TRANSFER FUNCTION FOR SPECIFIC OPTICAL SYSTEMS"
Feingeraete Tech., 22, 457 (1973)
The method is based on an algorithm for quick fourier transforms. Details are given of the theoretical basis and of the application of the method to a 2.8/180 optical objective, using a computer program (15 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; FOURIER TRANSFORMS;
Identifiers: POLYCHROMATIC TRANSFER FUNCTION; OPTICAL SYSTEMS; FOURIER TRANSFORMS; THEORETICAL BASIS; OPTICAL OBJECTIVE; COMPUTER PROGRAM

EMBLETON, T.F.
"IMPROVED MIRROR MOUNTING FOR OPTICAL INTERFEROMETERS"
J. Opt. Soc. Am., 45, 152 (1955)
No abstract provided.

FARCINADE, M.
"APPARATUS FOR INSPECTING SPECTACLE LENSES"
Mes. Regul. Autom., 43, 45 (1978)
The optoelectronic method and apparatus described were developed forthe quality control of moulded plastic spectacle lenses in mass production.
Descriptors: QUALITY CONTROL; INSPECTION; LENSES; OPTICAL TESTING
Identifiers: SPECTACLE LENSES; OPTOELECTRONIC METHOD; QUALITY CONTROL; MOULDED PLASTIC; MASS PRODUCTION; INSPECTION

FIRNETT, P.J. and WILSON, L.A.
"FORTRAN OPTICAL LENS DESIGN PROGRAM. VOL. 1 MATHEMATICAL SPECIFICATIONS"
Geometry, ray specification and tracing, system characteristics, computation and display of spot diagrams, sensitivity analysis, and cross setional plotting are described for FOLDP, Fortran Optical Lens Design Program. A digital computer program written in 7094 Fortran IV source language, FOLDP uses the principles of geometric optics to automatically design optical systems and can handle systems containing up to 100 surfaces, seven objects points, six colors, and 200 rays.
Descriptors: OPTICAL SYSTEMS; LENSES; CALCULATING APPARATUS, DIGITAL COMPUTER PROGRAMS; OPTICS; FORTRAN;

FLACK, R.D., Jr.
"SHERING INTERFEROMETER INACCURACIES DUE TO A MISALIGNED TEST SECTION"
App. Opt., 17, 2873 (1978)
No abstract provided.

FOUCAULT, L.
"MEMOIRE SUR LA CONSTRUCTION DES TELESCOPES EN VENE ARGENTE"
Ann. Obs. Imp. Paris, 5, 197 (1859)
No abstract provided.

FRIESEM, A.A. and LEVY, U.
"FRINGE FORMATION IN TWO-WAVELENGTH CONTOUR HOLOGRAPHY"
App. Opt., 15, 3009 (1976)
This paper presents a description of fringe formation in two-wavelength contour holography. Approximations are introduced primarily by restricting the recording wavelength difference with the aid of a tunable dye laser and by observing the contour fringes through a controlled viewing system aperture. Several holographic recording and readout arrangements are presented for which explicit and conveniently interpretable contour fringe formulations are derived. Finally, the results from a

set of experiments performed with each of the arrangements are offered as experimental evidence supporting the anlysis.

FRITZ, L.W. and SCHMID, H.H.
"STELLAR CALIBRATION OF THE ORBIGON LENS"
Photogramm. Eng., 40, 101 (1974)
Discusses the Complete evaluation of a new lens designed for photogrammetric surveys taken from orbital spacecraft. The F/3.5 wide-angle wild orbigon lens contains a reseau and is color corrected. A comprehensive stellar calibration of the lens at three apertures was performed at nos. A unique economical technique for combining multiple plates in a combined adjustment is presented. The adjustment results show that over the entire cone format the transformed radial symmetric distortion does not exceed 4.1 +or- 0.06 mum and the lens decentering distortion does not exceed 3.0 +or- 0.08 mum. Results of lens resolution and light transmission tests indicate an awar of 133 lines/mm at full aperture and a maximum variation of focal plane illumination of 12 percent (3. Refs.).
Descriptors: PHOTOGRAPHIC LENSES; CALIBRATION; ARTIFICIAL SATELLITES
Identifiers: STELLAR CALIBRATION; ORBIGON LENS; PHOTOGRAMMETRIC SURVEYS; WILD ORBIGON LENS; RESEAU; TECHNIQUE FOR COMBINING MULTIPLE PLATES; RADIAL SYMMETRIC DISTORTION; LENS DECENTRING DISTORTION; LIGHT TRANSMISSION; VARIATION OF FOCAL PLANE ILLUMINATION; LENS EVALUATION; SATELLITE PHOTOGRAPHY; WIDE ANGLE LENS; F/3.5 LENS; COLOUR CORRECTED; LENS RESOLUTION

GATES, J.W.
"THE EVALUATION OF INTERFEROGRAMS BY DISPLACEMENT AND STEREOSCOPIC METHODS"
J. Appl. Phys., 5, 133 (1954)
No abstract provided.

GLASSMAN, A.
"TESTS FOR LASER DISCS"
Optical Shop Ntotebook, IX, 49 (1975)
I would like to describe the tests for laser discs which are currently being used by Lawrence Livermore Laboratory and some of its vendors, with special emphasis on tests which are unique or more difficult for discs. Testing is important to the vendor so he knows when his product is completed and to the purchaser so he knows if he has obtained what he specified.

The tests one would like to do can be divided into two sections: tests for dimensional properties and tests for optical properties. The dimensional properties are length, width, diameter, thickness, edge profile, edge chamfer, edge chips, parallelism and flatness. The optical properties are: wavefront distortion, surface quality of faces, bubbles, inclusions, striae, refractive index, refractive index homogeneity, strain, absorption and doping concentration, edge coating quality and damage threshold.

GOLDBERG, B. and BENSON, N.C.
"APPARATUS FOR DETERMINING SPHERICAL ABERRATION OF CONVEX SURFACE OF PARABOLOID OF REVOLUTION"
J. Opt. Soc. Am., 37, 186 (1947)
No abstract provided.

GREENLAND, K.M.
"APPLIED OPTICS AT SIRA"
App. Opt., 8, 1947 (1969)
The research program is briefly described with special reference to improvements in methods of constructing and testing lenses and to applications of fourier transform optics in the on-line gauging of rods, wires, and fibers. Details are given of a pupil-scanning lens tester and of a guage for red-hot steel rods.
Descriptors: OPTICS; LENSES; OPT. INSTRUMENT TESTING; MICROMETRY; REVIEWS

GREY, D.C.
"A DEVICE FOR TESTING ASPHERIC SURFACES"
J. Opt. Soc. Am., 41, 876 (1951)
No abstract provided.

GRIGOR'EV, I.A.
"AN AUTOCOLLIMATION MICROSCOPE FOR SIZE MONITORING"
Meas. Tech., 17, 1693 (1974)
Explains the use of an autocollimation microscope in conjunction with a spherical lens, spherical mirror made of steel, or ordinary ball of diameter 0.5-16 mm for a variety of measurements on instrument parts or components of small machines (2 Refs.).
Descriptors: DISPLACEMENT MEASUREMENT; MACHINE TESTING; MONITORING; MICROSCOPY; LIGHT REFLECTION
Identifiers: SIZE MONITORING; AUTOCOLLIMATION MICROSCOPE; SPHERICAL LENS; SPHERICAL MIRROR; BALL; INSTRUMENT PARTS

HAEHNER, C.B.
"HIGH-VOLUME LENS TESTING"
W. Elec. Eng., 15, 33 (1971)
A system for measuring the quality of lenses for picturephone service adapts a classical laboratory testing technique to high volume production. A specially designed test pattern is projected through the lens and scanned by a photodetector. The results, displayed on paper tape or on an oscilloscope, can be directly compared against minimum required lens performance standards.
Descriptors: LENSES; LABORATORY APPARATUS AND TECHNIQUE; OPTICAL INSTRUMENT
Identifiers: LENS TESTING; MEASUREMENT; LABORATORY

TECHNIQUE; PRODUCTION TESTING; PICTUREPHONE; QUALITY

HEINISCH, R.P. and YOUNG, R.P.
"SOME OBSERVATIONS OF EMPIRICAL MIRROR SCATTER"

The near-axis scatter of infrared (10.6 mum) energy from high reflectivity metal mirrors is described. Effects of contamination on the scatter are described. Methods of evaluating various forms of contamination are presented and selected data are presented. Finally, the recording techniques for surface characteristics photographically are described along with a typical photograph of a large aspheric mirror.

HERRIOT, W.
"A PHOTOELECTRIC LENS BENCH"
J. Opt. Soc. Am., 37, 472 (1947)

No abstract provided.

HILBERT, R.S. and RIMMER, M.P.
"A VARIABLE REFRACTIVE NULL LENS"
App. Opt., 9, 849 (1970)

Null lenses, for use with rotationally symmetric but nonspherical surfaces, are extremely useful for testing during production. In general, each different system to be tested requires a different null lens. A variable null lens is proposed which consists of two aspheric plates, each of which introduces approximately fourth- or sixth-order spherical aberration. When the plates are inserted in a diverging beam, the effect on the wavefront may be changed by varying the plate spacing. The system may be used to test parabolas and other nonspherical mirrors at center of curvature, aspheric plates in conjunction with spherical mirros. and various other systems. Once the two plates have been produced and measured, the spacing of the plates used may be determined for each test. This would normally be done by computer, using any of the optimization techniques for lens design. Examples are shown, and an estimate of obtainable accuracy is given.

Descriptors: LENSES; OPTICAL INSTRUMENT TESTING

HOUSE, C. and STEELE, N.
"EVALUATION OF INFRARED SYSTEMS"
Electro-Optics/Laser International '76 UK, 38 (1976)

The manufacture of lenses and single components having either flat or aspheric reflective surfaces requires methods of testing. The method used for lenses is that of the line spread function, flatness is measured using either the Fizeau or Twyman and Green interferometers, and a linear transducer and recorder are employed with aspheric surfaces. The methods are discuseed (2 Refs.).

Descriptors: INFRARED IMAGING; OPTICAL TESTING; ASPHERICAL LENSES; LIGHT INTERFEROMETRY; EVALUATION;

Identifiers: LENSES; TESTING; LINE SPREAD FUNCTION; FLATNESS; INTERFEROMETERS; LINEAR TRANSDUCER; ASPHERIC SURFACES; IR

KOWALIK, W.
"INTERFERENCE MEASUREMENT OF CONTINUOUS HETEROGENEITIES IN OPTICAL MATERIALS"
App. Opt., 17, 2956 (1978)

A measuring method is described which is not limited by interferometer errors. Variations in the geometrical and optical thickness of the block under investigation and its refractive index may be measured by means of scanning three interferograms and using computer analysis. There also exists a possibility of calculating the rate of variation of these quantities according to coordinate alteration of the investigated block. Some measurement results are given, and analysis of measuring accuracy is carried out. Measuring accuracy for refractive index difference distribution may reach one part in 1 x 10 to the -7 for centimeter thick samples.

KREBS, G. and LOVE, S.L.
"THE AUTOCOLLIMATOR AS A SEMI-OBJECTIVE MEANS OF TESTING OPTICS AND PHOTO-OPTICAL SYSTEMS"
J. App. Photogr. Eng., 2, 158 (1976)

The autocollimator permits the user to seek a compromise between subjective opinion of lens and camera system quality and the highly objective transfer function approach. The authors explore a variety of purposes to which autocollimators may be applied for more or less sophisticated analyses of lens quality. Camera alignment and system performance. It covers basic principles of collimation and autocollimation. The different tests that may be performed using those instruments, and a set of specific procedures that may be used in carrying out these tests (6 Refs.).

Descriptors: OPTICAL INSTRUMENT TESTING: PHOTOGRAPHIC LENSES; CAMERAS
Identifiers: AUTOCOLLIMATOR; LENS QUALITY; CAMERA ALIGNMENT; SYSTEM PERFORMANCE; SEMIOBJECTIVE OPTICS TESTING; PHOTOOPTICAL SYSTEMS

KRYNIN, L.I.
"STATISTICAL EVALUATION OF THE ERRORS OF THE LENS THICKNESSES AND REFERENCE VERTEX DISTANCES"
Sov. J. Opt. Tech., 44, 106 (1977)

In a statistical study of parameters of components of lens systems the empirical lens thickness distribution was found to closely approximate with the Gaussian Distribution law. It is concluded from this and other tests that all relevant errors are random in nature (2 Refs. .

Descriptors: LENSES; ERROR STATISTICS;
Identifiers: ERRORS; LENS THICKNESSES; REFERENCE VERTEX DISTANCES; STATISTICAL EVALUATION

KUTTNER, P.
"REMARKS ON THE ACCURACY OF SPECTRAL RESPONSE MATCHING FOR MTF MEASUREMENTS"
Soc. Photo-Optical Instrumentation Eng., 98, 30 (1977)

Some parameters of greater or lesser importance for matching spectral response are discussed for specific lens types. The influence of the deviation of light-source color temperature and deviation of the detector's spectral response are shown for spectral energy distributions frequently used in practice. Although a general answer cannot be given. Certain trends and connections can be detected. The effect of different fluorescent phosphors on MTF measurements of stopped-down and high-aperture lenses is shown (8 Refs.).

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; LENSES;

Identifiers: SPECTRAL ENERGY DISTRIBUTIONS; FLUORESCENT PHOSPHORS; LIGHT SOURCE COLOUR TEMPERATUE DEVIATION; STOPPED DOWN LENSES; HIGH APERTURE LENSES

LOOMIS, J.S.
"ANALYSIS OF INTERFEROMETRIC DATA FOR THE MULTIPLE MIRROR TELESCOPE: OPTICS"
J. Opt. Soc. Am., 66, 1116 (1976)

No abstract provided.

LOOMIS, J.S.
"ANALYSIS OF INTERFEROGRAMS FROM WAXICONS"
Opt. Components, 171, (1979)

Axicon elements are used in cylindrical optical systems such as high-power chemical lasers. Interferometric tests of such elements cannot be interpreted by standard methods. Axicon aberrations of cone error and decenter error are define to help interpret such interferograms. A preprocessing option was added to FRINGE to treat axicon data. An example interferogram has been analyzed.

LYTLE, J.D. and PALMER, A.L.
"ASPHERIC PROFILE GAUGING USING A BOOTSTRAP DATA INTERPRETATION TECHNIQUE"
App. Opt., 18, 1064 (1979)

Accurate electromechanical gauging of steep aspheric profiles is often complicated by the complexity of the relationship between the locus of the probe tip center of curvature and the probe tip/asphere contact point. Solving for the contact point is usually done in an iterative manner, which is a fairly laborious computing chore, but since a considerable amount of sag information is conventionally produced by the lens desi program generating the aspheric surface, it is possible to shortcut the process by using these data to solve directly for the probe tip coordinates as a function of the aspheric prescription (3 Refs.).

Descriptors: ASPHERICAL LENSES; OPTICAL TESTING; SURFACE TOPOGRAPHY MEASUREMENT

Identifiers: BOOTSTRAP DATA INTERPRETATION TECHNIQUE; STEEP ASPHERIC PROFILES; ITERATIVE MANNER; SAG INFORMATION; LENS DESIGN PROGRAM; ASPHERIC PROFILE GAUGING; OPTICAL TESTING; ACCURATE ELECTROMECHANICAL GAUGING; PROBE TIP CENTRE OF CURVATURE; PROBE TIP ASPHERE CONTACT POINT

MACDONALD, J.
"COMPARISON OF RESULTS OF VARIOUS OTF CALCULATION PROGRAMS"
Opt. Acta, 22, 387 (1975)

The results of several OTF computer programs from different laboratories in Europe, Japan and the USA are compared for the case of a 6 in wide angle aerial camera lens. The comparison for large field angle is of particular interest and shows that significant errors are made in such regions.

Descriptors: TRANSFER FUNCTIONS; PHOTOGRAPHIC LENSES, COMPUTATIONAL PHYSICS

Identifiers: COMPARISON; OTF CALCULATION PROGRAMS; 6 IN WIDE ANGLE AERIAL CAMERA LENS; LARGE FIELD ANGLE

MAKSIMOV, L.S., MIKHNEV, R.A., and SHTANDEL, S.K.
"VIBRATION INSULATION OF EQUIPMENT FOR TESTING THE PERFORMANCE OF OPTICAL SYSTEMS"
Sov. J. Opt. Tech., 44, 689 (1977)

The allowable vibrations of instrument mounts for testing the performance of systems in terms of the diffraction spot, interference and Schlieren patterns are indicated. The results of these of vibration insulation during the testing of the long-focus optical systems are reported (5 Refs.).

Descriptors: OPTICAL INSTRUMENT TESTING; OPTICAL TESTING; LIGHT INTERFEROMETRY; SCHLIEREN SYSTEMS; TELESCOPES; LENSES

Identifiers: DIFFRACTION SPOT; SCHLIEREN PATTERNS; VIBRATION INSULATION OF EQUIPMENT; OPTICAL SYSTEM PERFORMANCE TESTING; INTERFERENCE PATTERNS; LONG FOCUS OPTICAL SYSTEMS; LARGE OBJECTIVES; CATADIOPTRIC TELESCOPE SYSTEMS; INTERFEROMETERS

MALACARA, D., CORNEJO, A., and NOBLE, R.H.
"TESTING DATA AND PROCEDURES FOR THE INAOE 210 CM. TELESCOPE"
Bol. Inst. Tonantzintla, 1, 79 (1974)

The testing procedures to be used during the fabrication of the mirrors for the Ritchey-Chretien telescope presently being made at the INAOE are described. All necessary numerical data for such tests are also included (4 Refs.).

Descriptors: ASTRONOMICAL TELESCOPES; MIRRORS; OPTICAL INSTRUMENT TESTING; ASTRONOMICAL TECHNIQUES;

Identifiers: TELESCOPE MIRROR TESTING; RONCHI TEST; RITCHEY CHRETIEN 210 CM. TELESCOPE; AXIAL WIRE TEST; HARTMANN TEST; HINDLE TEST; PRIMARY MIRROR; SECONDARY MIRRORS; SPOT DIAGRAMS; OFFNER COMPENSATING LENS

MARCHANT, A.C.
"BRIEF REVIEW OF RECENT BRITISH STANDARDS"
Soc. of Photo-Optical Instrumentation Eng., 98, 136 (1977)

Summary form only given. Since 1971. Five British Standards have been published on various aspects of the assessment of the performance of optical devices. The broad principles underlying these standards are discussed and the content of each briefly outlined.

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; MEASUREMENT STANDARDS; REVIEWS; OPTICAL INSTRUMENT TESTING; LENSES

Identifiers: BRITISH STANDARDS; OPTICAL DEVICES; PERFORMANCE ASSESSMENT

MARKS, R.J., II and BELL, S.V.
"ASTIGMATIC COHERENT PROCESSOR ANALYSIS"
Texas Tech. University, Lubbock, Texas (1978)

Certain applications in coherent optical processing of two-dimensional signals require the operation of imaging a signal in one dimension while simultaneously Fourier transforming it in the other. Such parallel operations can be performed by a number of different system designs. This paper presents a method of analyzing such systems by treating each dimension independently and using three basic component sub-systems. The method simplifies mathematical anlysis of system opertion and facilitates intuitive design for particular applications.

MARQUARDT, W.R.
"OPTICAL SYSTEM EVALUATION VIA COMPUTER SIMULATION"
Opt. Soc., Am., (1970)

A computer program has been written to predict statistically the performance of a lens system when the effects of manufacturing perturbations are included. A Monte Carlo technique is used to simulate manufactured lenses by sampling the distributions of the perturbations that affect the lens. The optical performance is then predicted on a per-lens basis and the results summarized in the distribution of performance. A demonstration verifying the performance-prediction capabilities of the program is presented for a particular lens formula. A comparison is made between predicted performance and measured performance, described either in terms of wavefront contours, spot diagrams, modulation transfer function, or a subjective quality factor.

Descriptors: OPTICAL SYSTEMS; CALCULATING APPARATUS, DIGITAL COMPUTER PROGRAMS; OPTICS; SIMULATION

MCDOWELL, M.W. and BOETTCHER, A.J.
"THE DESIGN OF APOCHROMATIC COLLIMATORS FOR USE IN MTF EVALUATION"
Optik, 48, 491 (1977)

Much emphasis in recent years has been placed on the design and construction of high speed objective lenses for use with detectors of extended red sensitivity. Refracting collimators supplied as standard with many of the less sophisticated MTF evaluation systems are of relatively simple construction and have limited spectral correction. As a result of this, errors can arise in the direct measurement of polychromatic MTF'S and axial colour of high speed objective lenses. Details are given of a 1500 mm focal length apochromatic collimator with a practically diffraction limited performance and low secondary spectrum (≈0.0001 EFL) which will minimize the occurrence of the above errors (12 Refs.).

Descriptors: OPTICAL COLLIMATORS; OPTICAL DESIGN TECHNIQUES; OPTICAL TRANSFER FUNCTION;

Identifiers: DESIGN; APOCHROMATIC COLLIMATORS; MTF EVALUATION; HIGH SPEED OBJECTIVE LENSES; 1500 MM FOCAL LENGTH; PRACTICALLY DIFFRACTION LIMITED PERFORMANCE; LOW SECONDARY SPECTRUM

MUMZHIU, A.M.
"A COMPLEX OF FACILITIES FOR TESTING SPECTACLE OPTICS"
Biomed. Eng., 12, 48 (1978)

The major parameters to be checked are the rear vertex refraction (in diopters), the optical strengths in principal sections (with the maximum and minimum refraction) for astigmatic lenses (in diopters), the positions of the principal sections (in degrees), the position of the optical center in a stigmatic lens (in mm), the direction of the line from vertex to base in a tapered lens (the section in which the prisma refraction is maximal. In degrees), the prismatic power for spectacle prisms (in prism diopters), the prismatic power for spectacle lenses (in prism diopters), and the lens diameter and thickness at the center (in mm). In addition, checks may be made on the glass quality, surface finish, birefringence, striations, bubbles, scratches, etc. (6 Refs.).

Descriptors: LENSES; OPTICAL TESTING; VISION; TEST FACILITIES; SENSORY AIDS

Identifiers: COMPLEX OF FACILIITES; TESTING SPECTACLE OPTICS; REAR VERTEX REFRACTION; OPTICAL STRENGTHS; PRINCIPAL SECTIONS; PRISMATIC POWER

MUNNERLYN, C.R.
"PICTURES FROM THE DIGITAL INTERFEROMETER"
Optical Shop Notebook, IX, 29 (1975)

No abstract provided.

MUNROE, J.L. and WOODFIN, G.
"AN OPTICAL EVALUATION LABORATORY"
Los Alamos Scientific Laboratory, University of California, Los Alamos, NM (1979)

The Antares CO2 laser system is being constructed at the Los Alamos Scientific Laboratory (LASL) to investigate inertial confinement fusion. Antares will be a very large laser system, with 72 beams and a total beam area of some 6 square meters. There will be thousands of optical components, predominantly copper-plated mirrors and sodium chloride windows. To coordinate the specification, procurement, evaluation, and disposition of these components, a centralized Optical Evaluation Laboratory (OEL) is being set up. The OEL is principally a quality-control facility for routinely evaluating the optical performance of components and assemblies with apertures of up to 18-inch diameter. However, the OEL has a much broader involvement and responsibility for the Antares optics. Virtually every piece of optics in Antares will be specified and ordered through the OEL. After acceptance, the OEL will be responsible for tracking the history of each optcial component via a computerized data base. This paper describes the Optical Evaluation Laboratory facility and its operation.

MURTY, M.V.R.K.
"INTERFEROMETRY APPLIED TO TESTING OF OPTICS"
Bull. Opt. Soc., India, 1, 29 (1967)
No abstract provided.

OPLINHRT, D.W., PARKER, B.S., and CHIANG, F.P.
"EDGE EFFECT STUDIES IN FIBER REINFORCED LAMINATES"
Exp. Mech., 14 347 (1974)
No abstract provided.

PASTOR, J.
"HOLOGRAM INTERFEROMETRY AND OPTICAL TECHNOLOGY"
App. Opt., 8, 525 (1969)
No abstract provided.

PLUMMER, W.T.
"RAPID EVALUATION OF EXTENDED-FIELD PHOTOGRAPHIC QUALITY OF LENSES"
Soc. Photo-Opt. Inst. Eng. (1974)
Monitoring of high-volume lens manufacture for polaroid land photography requires an acceptance criterion which is relevant to picture quality and suitable for automatic testing. At multiple field locations a single-frequency modulation measurement adequately defines the MTF for the low spatial frequencies of interest, and can be interpreted easily in terms of the root-mean-square blur of the point spread function (1 Ref.).
Descriptors: PHOTOGRAPHIC LENSES; OPTICAL INSTRUMENT TESTING; OPTICAL IMAGES; TRANSFER FUNCTIONS;
Identifiers: EXTENDED FIELD PHOTOGRAPHIC QUALITY; MODULATION TRANSFER FUNCTION; POINT SPREAD FUNCTION; ROOT MEAN SQUARE BLUR; LENSES; LENS MANUFACTURE; AUTOMATIC TESTING

POLSTER, H.D., PASTOR, J., SCOTT, R.M., CRANE, R., LANGENBECK, P.H., PILSTON, R., and STEINBERG, G.
"NEW DEVELOPMENTS IN INTERFEROMETRY"
This article is based on a series of talks presented by personnel of the Perkin-Elmer Corporation at a symposium held in September 1967 and thereafter brought up to date for inclusion in the APPLIED OPTICS feature discussing Interferometry vs. Spectroscopy.

POPOV, G.M.
"THE TESTING OF NON-SPHERICAL MIRRORS BY MEANS OF COMPENSATION LENSES"
Izv. Krymskij Astrofiz. Obs., 40, 173 (1969)
Systems for the testing (by means of Foucault Null Test and Ronchi Test) of paraboloids, hyperboloids and oblate spheroids for telescopes have been computed. Optical systems are shown diagrammatically. The possibility of testing the concave paraboloids and hyperboloids of aperture ratio F/3.5-F/4 upward and concave oblate

spheroids of aperture ratio F/1.5 upward is shown. The compensation lens has a diameter about 1/10 of that of the mirror being testd. The systems have been employed in the optical workshop of the crimea astrophysical observatory.

Descriptors: MIRRORS; OPTICAL INSTRUMENT TESTING;

Identifiers: NONSPHERIC MIRRORS; COMPENSATION LENSES; TESTING SYSTEMS; OPTICAL INSTRUMENTS; PARABOLOIDS; HYPERBOLOIDS; OBLATE SPHEROIDS

POST, D.
"CHARACTERISTICS OF THE SERIES INTERFEROMETER"
J. Opt. Soc. Am., 44, 243 (1954)
No abstract provided.

PURYAYEV, D.T. and SAVOSTIN, T.D.
"A PROFILE-CONTROL METHOD FOR ASPHERICAL SURFACES"
Sov. J. Opt. Tech., 36, 706 (1969)
No abstract provided.

RODRIGUEZ-TORRES, C.
"MULTIPLE SOURCE TESTING OF CAMERA SYSTEMS"
Opt. Sci. Tech. Rept., 54 (1970)
No abstract provided.

SAUNDERS, J.B.
"IN-LINE INTERFEROMETER"
J. Opt. Soc. Am., 44, 241 (1954)
No abstract provided.

SAUNDERS, J.B.
"PARALLEL TESTING INTERFEROMETER"
J. Res. Nat. Bur. Stand., 61, 491 (1958)
No abstract provided.

SAUNDERS, J.B.
"A SIMPLE, INEXPENSIVE WAVEFRONT SHEARING INTERFEROMETER"
App. Opt., 6, 1581 (1967)
No abstract provided.

SCHUMACHER, E.R.
"A PRECISION ALL-PURPOSE OPTICAL TESTER"
App. Opt., 5, 475 (1966)
No abstract provided.

SCHUTZ, V. and WEBB, W.E.
"STUDY OF TECHNIQUES FOR THE FABRICATION AND TESTING OF LARGE OPTICS FINAL REPORT"

Descriptors: GRINDING (MATERIAL REMOVAL); MIRRORS; OPTICAL EQUIPMENT FABRICATION; GRINDING MACHINES; OPTICAL PROPERTIES

SHAGAM, R.N., SLADKY, R.E., and WYANT, J.C.
"OPTICAL FIGURE INSPECTION OF DIAMOND-TURNED METAL MIRRORS"
Opt. Eng., 16, (1977)

This paper demonstrates that the optical testing of diamond-turned surfaces is best accomplished by interferometry and not by tests which measure wavefront slope. Certain conditions regarding the interferometer configuration must be met in order to generate meaningful and accurate interferograms. A 40 cm diameter aperture modified Mach-Zehnder interferometer mounted directly on the diamond-turning lathe to facilitate rapid testing of figure between fabrication cuts is described. Results for a spherical surfae tested in a Twyman-Green interferometer and an off-axis parabola tested in the Mach-Zehnder interferometer are illustrated.

SHAND, W.A.
"IMPORTANCE OF SPECTRAL BANDWIDTH IN QUALITY ASSURANCE OF NIGHT VISION LENSES"
Opt. Eng., 15, 211 (1976)

Considers the nature and magnitude of the influence of the spectral bandwidth on the MTF of a night vision objective as measured during testing and quality control and the relationship between this and the MTF values applying during the actual use of the objective. It is shown that the practical constraints which must be applied to the quality control procedures, and variations in spectral characteristics, may lead to widely differing MTF values in these two situations. The origins of these differences are also discussed.

Descriptors: LENSES; TRANSFER FUNCTIONS; OPTICAL TESTING; QUALITY CONTROL; PHOTODETECTORS; IMAGE CONVERTORS;

Identifiers: SPECTRAL BANDWIDTH; QUALITY ASSURANCE; NIGHT VISION LENSES; MTF; TESTING; QUALITY CONTROL; PRACTICAL CONSTRAINTS

SHANNON, R.R. and RODRIGUEZ-TORRES, C.
"PAIRED SOURCE TESTING OF OPTICAL SYSTEMS"
Appl. Opt., 10, 264 (1971)

No abstract provided.

SILVERTOOTH, E.W.
"HIGH FINESSE INTERFEROGRAMS"
App. Opt., 10, 1980 (1971)

Shannon and Rodriguez-Torres have shown a simple means of producing an interferogram at a plane other than that containing the focused images of a pair of mutually coherent poin sources.

The finesse of the fringe pattern so produced may be increased by providing more than two sources, or wavefronts. If the family of plane wavefronts presented to the lens to be tested is derived from a laser collimator in the form of a beam expander, the introduction of a pair of mutually slightly tilted partial mirrors between the laser and the first element of the beam expander will provide the desired multiplicity of wavefronts exiting the collimator.

SLAYMAKER, F.H.
"NOISE IN MTF MEASUREMENTS"
App. Opt., 12, 2709 (1973)

The effect of shot noise on the MTF of a lens when measured by means of an edge scan is treated both analytically and experimentally. It is shown that the variance in the MTF, introduced by the shot noise, establishes an upper bound on the magnitude of any systematic error introduced into the MTF measurement by the noise. Both the variance and the systematic bias in the MTF measurement due to the noise can be reduced to arbitrarily small values by controlling the electrical bandwidth and the scanner velocity. Expressions are given for the maximum scanner velocity and the minimum elapsed time for the scan as a function of the acceptable variance.

SMARTT, R.N.
"A VARIABLE TRANSMITTANCE BEAM SPLITTER"
App. Opt., 9, 970 (1970)

No abstract provided.

SOKOLOVA, N.S.
"LENS DECENTERING AND DEFORMATION TESTING DURING THE ASSEMBLY OF OBJECTIVES"
Sov. J. Opt. Tech., 40, 499 (1973)

Several methods of testing are discussed with particular reference to using transmitted light, to use of antocollimation, to the contact method of lens centering and to surface deformation. It is concluded that specialised instrument are required for testing at each stage of assembly, and that remote methods of testing surface quality should be developed (2 Refs.).

Descriptors: OPTICAL TESTING; LENSES; SURFACE MEASUREMENT;
Identifiers: DEFORMATION TESTING; ASSEMBLY OF OBJECTIVES; TRANSMITTED LIGHT; AUTOCOLLIMATION; CONTACT METHOD; LENS CENTERING; SURFACE DEFORMATION; SURFACE QUALITY

SOKOLOVA, N.S.
"DECENTERING TOLERANCES OF OBJECTIVE LENSES"
Sov. J. Opt. Tech., 40, 448 (1973)

Four interrelated quanitities determining lens decentering are specified and numerical examples given. Aberrations of a centered system are shown schematically. 3 currently used assembly methods are discussed. Certain conclusions are drawn including the advice that tolerance on lens decentering should be calculated (by computer) based on the allowable size of the circle of confusion in the objective image plane.

Descriptors: OPTICAL TESTING; LENSES; ABERRATIONS;
Identifiers: OBJECTIVE LENSES; CIRCLE OF CONFUSION; OBJECTIVE IMAGE PLANE; DECENTERING TOLERANCES; ABERRATIONS

STRAKUN, G.I., MUMZHIU, A.M., and MITSEVICH, I.A.
"AUTOMATIC DIOPTOMETER WITH A PROJECTION READOUT SYSTEM"
Sov. J. Opt. Tech., 45, 356 (1978)

The operating principle and construction of an automatic dioptometer are briefly described. The major advantages of the instrument compared with the first automatic measuring dioptometer are discussed. The instrument measures the vertex refraction of nonastigmatic lenses within the 0 to +or- 8 diopters interval with an error of 0.01 diopter and is designed for measuring the standard lenses used for the checking of visual dioptometers, and it can also serve for checking proof lenses and nonastigmatic spectacle lenses of the first group (3 Refs.).

Descriptors: AUTOMATIC TEST EQUIPMENT; OPTICAL TESTING; OPTICAL PROJECTORS; REFRACTOMETERS; LENSES;
Identifiers: PROJECTION READOUT SYSTEM; OPERATING PRINCIPLE; CONSTRUCTION; AUTOMATIC DIOPTOMETER; VERTEX REFRACTION; NONASTIGMATIC LENSES; ERROR; STANDARD LENSES; CHECKING

SWIFT, D.W.
"HALF TONE DOT REPRODUCTION AS A MEANS OF LENS TESTING"
Opt. and Laser Tech., 8, 175 (1976)

A simple relationship was sought between lens MTF and the results of photographing half-tone dot patterns. Qualitative understanding was more important than quantitative accuracy, and therefore emphasis was laid on developing an inexact but helpful model. This was successful and has thrown useful light on the results which had been observed.

Descriptors: LENSES; OPTICAL TESTING;
Identifiers: LENS TESTING; LENS MTF; HALF TONE DOT REPRODUCTION

TANNER, L.H.
"CAMERA TESTING BY USE OF SPECKLE PATTERNS"
App. Opt., 13, 2026 (1974)

Some light of a laser beam entering the camera is diffusely reflected by the film and forms a speckle pattern in the plane of the lens diaphragm. Movement of the spot on the film produces speckle movement and the rate of movement is inversely proportional to the spot size. The focus can be estimated to within 0.1 of the Rayleigh limit. All the monochromatic aberrations (except distortion) of the camera lens can be measured. Analogy is drawn with the Foucault test. An analysis of aberrations is given. Results are described for an F/2 Takumar lens (8 Refs.).

Descriptors: CAMERAS; PHOTOGRAPHIC LENSES; ABERRATIONS; OPTICAL INSTRUMENT TESTING;
Identifiers: CAMERA-TESTING; SPECKLE PATTERNS; LASER BEAM; LENS DIAPHRAGM; SPECKLE MOVEMENT; SPOT SIZE; FOCUS; RAYLEIGH LIMIT; MONOCHROMATIC ABERRATIONS; DISTORTION; FOUCAULT TEST; TAKUMAR LENS

TAYLOR, H.D.
"METAL MIRRORS IN THE LARGE"
Opt. Eng., 14, 559 (1975)

The state of the art in manufacturing large one piece metal mirrors has advanced dramatically in the past 10 years, following important pioneer work by NASA's Jet Propulsion Laboratory in 1965. Since that time, several additional large solar simulator mirrors have been manufactured. Careful mechanical and thermal design analysis and structure material selection are important elements in a successful finished product. Manufacturing techniques for mirror structure fabrication borrow from the heavy metal industry, while optical processing still follows relatively classical methods. Requirements for electroless nickel plating, sea transportion, and improved long term optical surface protection are challenges that have resulted in innovative practical solutions. The recently completed 5.5 meter (18 foot) diameter mirror for the Japanese National Space Development Agency's new space center at Tsukuba, Japan, exemplifies much of the technical advancement achieved over the last 10 years.

THACKERAY, D. and WICKES, M.
"SIMPLE TESTS FOR PROJECTION LENSES"
J. Photogr. Sci., 22, 306 (1974)

The construction of some simple test slides, and their use in the visual assessment of the aberrations of projection lenses, is described here. The kinds of aberration, and their magnitudes, if significant in the visual image, can be determined readily.

Descriptors; LENSES; ABERRATIONS;
Identifiers; OPTICAL TESTING; PROJECTION LENSES; ABERRATION; IMAGE DEFECTS; SEIDEL ABERRATIONS; CHROMATIC ABERRATION; SPHERICAL ABERRATION; COMA; ASTIGMATISM

THIRY, H.
"MEASUREMENTS OF MODULATION TRANSFER FUNCTION"
Rev. HF, 8, 73 (1970)

The modulation transfer function (MTF) of photographic and television objectives has been measured by the Fourier analysis of a square-wave ruling. This ruling is illuminated by a coherent plane wave and then imaged by the objective. A photomultiplier scans the spectrum through a slit. A real image of the ruling has also been recorded on a photographic plate and the Fourier analysis of the photographic image gives the MTF of the whole system.

Descriptors: LENSES, PHOTOGRAPHIC; OPTICAL INSTRUMENT TESTING; OPTICAL VARIABLES MEASUREMENT; TRANSFER FUNCTIONS

THORN, L.B. and DREITZLER, D.R.
"AEROSOL AVERAGE-DENSITY DETERMINING SYSTEM"
Department of the Army, Washington, DC, Report No. PAT-APPL-579 657

Light shown through a space containing smoke or an aerosol is detected from several paths through the space. The light may be gathered from physically separated optical fibers feeding a common photodetector, or several physically separated, series-connected photodetectors may be used. The total amount of light reaching the photodetector(s) is directly related to the average density of the smoke or aerosol.

Descriptors: PATENTS; AEROSOLS; DENSITY; PHOTODETECTORS; SMOKE; FIBER OPTICS
Identifiers: PAT-CL-356-201; DESIGN CRITERIA; PERFORMANCE EVALUATION; NTISGPA

VAN HEEL, A.C.S.
"OPTICAL PRECISION METHOD TO MEASURE THE FORM OF A REFLECTING SURFACE"
J. Opt. Soc. Am., 41, 876 (1951)
No abstract provided.

VENZHEGA, N.S., EVTEEVA, N.P., KLIMANOVA, N.P., and KHLEBNIKOV, F.P.
"EXPERIENCE WITH THE USE OF A SEMIAUTOMATIC INSTRUMENT FOR THE QUALITY TESTING OF SERIALLY PRODUCED CAMERA OBJECTIVES BY MEASURING THE MODULATION TRANSFER COEFFICIENTS"
Sov. J. Opt. Tech., 45, 24 (1978)
The results of the use of a semiautomatic instrument based on a measurement of the modulation transfer coefficients (MTC) of an objective being tested at two points of the field at two spatial frequencies, for evaluating the quality of mass-produced objectives are discussed. An estimate of the measurement error is given (4 Refs.).
Descriptors: PHOTOGRAPHIC LENSES; MEASUREMENT ERRORS; QUALITY CONTROL; OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; PRODUCTION TESTING;
Identifiers: QUALITY TESTING; SERIALLY PRODUCED CAMERA OBJECTIVES; SEMIAUTOMATIC INSTRUMENT; MODULATION TRANSFER COEFFICIENTS; MEASUREMENT ERROR

VON BIEREN, K.
"INTERFEROMETRY: OPTICAL TESTING"
Appl. Opt., 12, 1642 (1973)
The performance of a Fourier transform lens is analyzed with the help of a new interferometric device that records the aberration function along any selected section of the wavefront. These interferometric plots, which carry an automatic calibration, are analogous to the familiar geometric-optical fan ray traces and thus provide the means to compare the performance of completed lens systems with the design criteria. The interferometer is particularly well suited to test Fourier transform lenses; however, it is readily modified to investigate imaging systems as well. Therefore, photographic objectives or microscopes may also be analyzed with this interferometer, which also provide considerable freedom from alignment requirements (7 Refs.).
Descriptors: FOURIER TRANSFORMS; LENSES; LIGHT

WAI-MIN, L. and MCCROBIE, G.L.
"WAVELENGTH WEIGHTING FOR MTF ANALYSIS"
J. Opt. Soc. Am., 63, 1276 (1973)
When designing lenses, polychromatic MTF response is calculated by use of wavelengths and weights based on the spectral distribution of the optical system. There are many different ways to determine what wavelengths and weights sould be used for evaluation. This paper discusses four commonly used methods. Method one uses equal-energy bands

with unequal wavelengths. Method two is biased toward the peak wavelength. Method three uses equal-wavelength bands. The wavelength representing each band is that which is defined as the center of equal energy within the band. Method four is equal-wavelength bands. The wavelength representing each band is that which is defined as the middle wavelength in the interval. The results of each method are compared and analyzed for three photographic lenses.

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTING;

Identifiers: WAVELENGTH WEIGHTING; LENSES; PEAK WAVELENGTH; PHOTOGRAPHIC LENSES; POLYCHROMATIC MODULATION TRANSFER FUNCTION RESPONSE

WALKER, B.H.
"LENS EVALUATION WITH BASIC LABORATORY EQUIPMENT"
Opt. Spectra, 4, 44 (1970)

No abstract provided.

WEEKS, R.F., PLUMMER, W.T., TING, L.K.M., and GOLD, N.
"TESTING OF LENSES FOR POLAROID LAND PHOTOGRAPHY"
J. Opt. Soc. Am., 63, 1274 (1973)

The optical-performance requirements of photographic objectives used for polaroid land photography differ significantly from the requirements for similar lenses designed for other purposes. It is important to recognize the contributions of the photographic material and the limiations of the eye in specifying and qualifying the lenses used to produce the hand-held prints. The rationale leading to the choice of performance criterion for the four-element objective used in the new SX-70 camera system is discussed.

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTING;

Identifiers: TESTING; LENSES; POLAROID LAND PHOTOGRAPHY

WETHERELL, W.
"ULTRAVIOLET AND VISIBLE SCATTERED LIGHT EFFECTS ON THE OPTICAL PERFORMANCE OF THE LARGE SPACE TELESCOPE"
Itek Cor., Tech. Report #PFR-74-161 (1974)

No abstract provided.

WILLIAMS, T.L.
"A SPOT DIAGRAM GENERATOR FOR LENS TESTING"
Opt. Acta, 15, 553 (1968)

An instrument for measuring the geometrical abberation of a lens operates by scanning the lens pupil with a 'ray' of light and measuring the coordinates of the ray intersection points in the image plane using a position-sensitive photocell. The ray intersection points are displayed as a spot diagram on a cathode ray tube. Up to 300 rays are traced through the lens in under 1 sec. Facilities are included for automatically counting the total number of rays traced through the lens as well as the number intersecting the image plane within an area defined by four adjustable boundaries. Two detectors are available for the instrument, one covers the visible spectrum and the other the near infrared.

Descriptors: LENSES; OPTICAL INSTRUMENTS TESTING; ABERRATIONS, OPTICAL

WILLIAMS, T.L. and ASHTON, A.
"THE USE OF STANDARD TEST LENSES FOR VERIFYING THE ACCURACY OF OTF EQUIPMENT"
App. Opt., 8, 2007 (1969)

The design and development of a 50-mm plano-convex lens as a test standard for OTF equipment is described. The lens has been used for checking and comparing OTF measurements made by laboratories in several countries, and the preliminary results and conclusions of this investigation are also described.

Descriptors: OPT. INSTRUMENT TESTING; LENSES, ASPHERICAL; STANDARDS; OPT. SYSTEMS

WILSON, R.G.
"WAVEFRONT-ERROR EVALUATION BY MATHEMATICAL ANALYSIS OF EXPERIMENTAL FOUCAULT-TEST DATA"
App. Opt., 14, 2286 (1975)

Experimental photometric Foucault-test data obtained for a 20 cm-DIA, F/5 spherical mirror are analyzed using diffraction theory. An integral equation gives the complex amplitude and irradiance distribution in the Foucault patterns as a function of wavefront error. The equation is inverted and the inversion formulation is applied to the experimental results to determine wavefront errors which are compared with those determined with a scatter-plate interferometer. Discrepancy between the measurements by the two methods was 0.002Lamda (32 Refs.).

Descriptors: OPTICAL TESTING; GEOMETRICAL OPTICS; LIGHT DIFFRACTION; LENSES; MIRRORS; MEASUREMENT ERRORS;

Identifiers: MATHEMATICAL ANALYSIS; SPHERICAL MIRROR; DIFFRACTION THEORY; INTEGRAL EQUATION; COMPLEX AMPLITUDE; IRRADIANCE DISTRIBUTION; INVERSION FORMULATION; WAVEFRONT ERROR EVALUATION; FOUCAULT TEST DATA

WETHERELL, W.M.
"PYROELECTRIC TELEVISION APPLIED TO INSTRUMENTATION WITH INFRARED LASERS"
Proc. Soc. Photo-Opt. Instr. Engrs., 110, 63 (1977)

The broad spectral response of pyroelectric vidicons has led to their use with a wide variety of lasers; moreover, the storage property of the pyroelectric target permits imagery with pulsed radiation. Specific applications include recording interferograms for evaluation of infrared optical materials and complete lenses; measuring the spectra of backscattered radition from plasmas produced by pulsed lasers; mutual alignment of visible and infrared lasers for precise intercomparison of wavelengths (5 Refs.).

Descriptors: TELEVISION CAMERAS; PYROELECTRIC DEVICES; TELEVISION APPLICATIONS; INFRARED DETECTORS;

Identifiers: PYROELECTRIC VIDICONS; BACKSCATTERED RADIATION; INTERFEROGRAM RECORDING; PLASMA SPECTROSCOPY; LASER ALIGNMENT

ZIMMERMAN, J. and REYNOLDS, B.R.
"ASPHERIC ELEMENTS FOR PERFORMANCE IMPROVEMENT AND COST REDUCTION IN INFRARED SYSTEMS"
Soc. Photo-Opt. Instr. Eng., 131, 50 (1978)

Improved image quality, reduced shading and higher transmission can be obtained, while at the same time the system cost is reduced. The manufacturing and test technologies which allow for cost effective use of aspherics are described. An advanced small FLIR which uses aspherics is cited as an example of the concepts presented (5 Refs.).

Descriptors: INFRARED IMAGING; ASPHERIC LENSES; OPTICAL TESTING;

Identifiers: PERFORMANCE IMPROVEMENT; COST REDUCTION; IMAGE QUALITY; SHADING; TRANSMISSION; TEST TECHNOLOGIES; ASPHERICS; MANUFACTURING TECHNOLOGIES; FORWARD LOOKING IR SYSTEMS

19 REVIEW PAPERS

BRIERS, J.D.
"INTERFEROMETRIC TESTING OF OPTICAL SYSTEMS AND COMPONENTS: A REVIEW"
Opt. Laser Technol., 4, 28 (1972)
No abstract provided.

CRAWFORD, D.L., MEINEL, A.B., and STOCKTON, M.W.
"A SYMPOSIUM ON SUPPORT AND TESTING OF LARGE ASTRONOMICAL MIRRORS"
Opt. Sci. Ctr. Univ. Ariz. Tech. Rept. No. 3 (1968)
No abstract provided.

DEVANY, A.S.
"CORRELATIVE BETWEEN RONCHIGRAMS AND INTERFEROGRAMS"
Appl. Opt., 17, 3022 (1978)
In optical figuring, pitch polishers with either cutout or scratched profiles are often used. Much time and effort are lost trying to figure the optical element's surface with previuosly made-up polishers. In this Note we develope a correcting polisher from the test patterns slopes.

DUKHOPEL, I.I.
"INTERFERENCE METHODS AND INSTRUMENTS FOR INSPECTING OPTICAL FLATS"
Sov. J. Opt. Technol., 38, 570 (1971)
No abstract provided.

FORMAN, P.
"EXCEPTS FROM REMARKS ON INTERFEROMETER AT ROCHESTER"
Opt. Shop Notebook, IX, 29 (1975)
No abstract provided.

HARTMAN, R.
"OPTICAL TESTING/AN OVERVIEW"
Opt. Shop Notebook, IX, 64 (1975)
No abstract provided.

KHUN, H.
"NEW TECHNIQUES IN OPTICAL INTERFEROMETRY"
Rept. Phys. Soc. Progr. Phys., 14, 80 (1951)
No abstract provided.

MURTY, M.V.R.K.
"INTERFEROMETRY APPLIED TO TESTING OF OPTICS"
Bull. Opt. Soc., India, 1, 29 (1967)
No abstract provided.

PRIMAK, W.
"THE DETERMINATION OF THE ABSOLUTE CONTOURS OF OPTICAL FLATS"
Appl. Opt., 6, 1917 (1967)
Emerson's procedure (the one in use at the National Bureau of Standards) for determining the absolute contours of optical flats are refined to increase the precision of the method and the speed of taking readings. The fringes were scanned over a photoelectric detector and the intensity profile presented on an oscilloscope. Setting accuracy of a fraction of a hundredth of a fringe was achieved. The data were gathered on a data logger. A complete set of data was obtained in about 5 min. The precision of determining a set of differences of two plates was approximately 1/6000 fringe and the precision achieved in determining the absolute plate contours is estimated as 0.005 fringe. The problem of extending the method to 0.002 fringe is discussed.

REID, C.D.
"A HISTORY OF THE TESTING OF PHOTOGRAPHIC LENSES I"
Photogr. Sci. Enge., 10 241 (1966)
No abstract provided.

RITCHEY, G.W.
"ON METHODS OF TESTING OPTICAL MIRRORS DURING CONSTRUCTION"
Astophys., J., 19, 53 (1904)
No abstract provided.

SHANNON, R.R.
"CLOSING THE LOOP IN OPTICAL SYSTEM DESIGN"
IEEE Trans. Aerosp. Electron. System., AES-5, 273 (1969)
No abstract provided.

SWYT, D.
"NATIONAL MEASUREMENT SYSTEM: MICROSTUDY OF OPTICS"
NBS, Washington (1975)
As regular readers of the NCSL Newletter are aware, NBS has been conducting an evaluation of the network of measurement operations in the U.S. that has come to be called the National Measurement System. Previous articles in this series have discussed the nature and purpose of thie study, briefly, it seeks to determine the modes of operation and to gauge the economic dimensions of the system in order that the information acquired might aid NBS in its mission to service that system.

This summary report deals with one of twenty-three substudies in the overall survey and covers three fields of optics pertaining to: (1) diffuse visual transmission density standards (2) microcopy resolution charts, and (3) lens evaluation and microdensitometry.

A model of some of the interacting elements of the measurement system is given in the accompanying figure. The six level structure outlines: (1) The Scientific and Technological Base/International Agreements (2) Recognized National Standards Organizations, (3) National and Instrument Standards, (4) Artifacts for Transfer and Control, (5) Instruments for Transfer, and (6) Point of Application of Standards.

TEW, E.J.
"MEASUREMENT TECHIQUES USED IN THE OPTICS WORKSHOP"
Appl. Opt., 5, 695 (1966)
No abstract provided.

WEHN, R.
"DIE METHODE DER RONCHI-GITTER IN DER PRAXIS"
(THE METHOD OF RONCHI-RULING IN PRACTICE)
Atti Fond. Giorgio Ronchi Contrib. Ist. Naz. Ottics, 17, 39 (1962)
No abstract provided.

WILLEY, R.R.
"CHARACTERISTICS AND TESTING OF A CASSEGRAIN TYPE TELESCOPE"
Sky Teles., 23, 226 (1962)
No abstract provided.

CAMPBELL, J.W.
"ELECTRONIC SELF-MONITORING SEAL"
Sandia Labs., New Mexico (1978)

The Electronic Self-Monitoring Seal is a new type of security seal which distributes its identity information through time. The identity information is a function of the individual seal, time and seal integrity. A description of this seal and its characteristics are presented. Also described are the use cycle for the seal and the support equipment for programming and verifying the seal.

Descriptors: SEALS; PHYSICAL PROTECTION DEVICES, ELECTRONIC EQUIPMENT, EVALUATION, FIBER OPTICS, NUCLEAR FUELS, OPTICAL SCANNERS, REMOTE SENSING, SAFEGUARDS, SPECIFICATIONS

Identifiers: ERDA/055001, ELECTRONIC RECORDING, SEALS(STOPPER-S), NTISDE

CANDLER, C.
MODERN INTERFEROMETERS
Hilger and Watts, London (1951)

No abstract provided.

COOK, A.H.
INTERFERENCE OF ELECTROMAGNETIC WAVES
Clarendon Press, Oxford (1971)

No abstract provided.

CRAWFORD, D.L.
THE CONSTRUCTON OF LARGE TELESCOPES
Int. Astron. Union Symp., 27 (1966)

No abstract provided.

DEVE, C.
OPTICAL WORKSHOP PRINCIPLES
Hilger and Watts, Ltd, London (1945)

Chapter VI. Optical Tests in Workshop describes some tests, especially Newton's tests, and angle measurements in prisms.

FRANCIA, T.
"GEOMETRICAL AND INTERFERENTIAL ASPECTS OF RONCHI TEST"
Optical Image Evaluation Symp. (NBS Circular 256) 161 (1954)

No abstract provided.

FRANCON, M.
OPTICAL INTERFEROMETRY
Academic Press, N.Y. (1966)
The following two chapters have a good description of the interferometric optical testing procedures: XI. Interferential Study of Wavefronts and XVI. Diverse applications of Interference.

FRANCON, M. and MALLICK, S.
POLARIZATON INTERFEROMETERS
Wiley-Interscience, N.Y. (1971)
This book contains a very brief description of some polarization interferometers, especially the following chapter; VIII. Testing of Optical Systems.

GARDNER, I.C.
OPTICAL IMAGE EVALUATION
N.B.S. Circular 526 (1954)
Introduction
1. The diffraction theory of aberrations by F. Zernike
2. The contrast of optical images and the influence of aberrations by A. Marechal
3. Diffraction images produced by fully corrected objectives of high numerical aperture by H. Ostberg and R. McDonald
4. Bases for testing photographic objectives by I.E. Howlett
5. Quality aspects of the aerial photographic system by M. Herzberger
6. A mathematical model of an optical system by M. Herzberger
7. Methods and apparatus for measuring performance and quality of optical instruments by A. Arnulf
8. Image quality as used by the Government inspector of visual telescopic instruments by H.S. Coleman
9. Application of Fresnel diffraction to measurements of high precision by A.C.S. van Heel
10. Image structure and test data by J. Baker
11. Geometrical and interferential aspects of the Ronchi test by G. Toraldo di Francia
12. A combined test procedure for camera lenses, and photo-electric examination of intensity distribution in line images, by E. Ingelstan and P. Lindberg
13. Measurements of energy distribution in optical images by R.E. Hopkins, H. Kerr, T. Lauroesch, and V. Carpenter
14. Optical calculations at the National Burea of Standards, by D. Feder
15. Resolving power of airplane-camera lenses by F. E. Washer
16. Theory of resolving power, by E.W.H. Selwyn
17. A new system of measuring and specifying image definition, by O.H. Schade

18. Position of best focus of a lens in the presence of spherical aberration by R. Kingslake
19. Image evaluation by edge gradients by A. Cox
20. A proposed approach to image evaluation by R.V. Shack, Excerpt from letter from T. Smith

HOPKINS, R. E. and DUTTON, D.
LENS TEST STANDARDIZATION STUDY
Rochester Univ. N.Y. Inst. Of Optics (1970)

The aim of the study was to assess the current state of the current state of the art of measuring and computing the MTF/OTF of lenses or optical systems. It is intended to furnish guidance for the posible revision of Standard MIL-STD-150A, should it appear desirable and feasible to make wider use of the MTF concept in writing specification for or making physical evaluations of optical systems. Data were collected to make comparisons of results obtained by different laboratories (a) of theoretical MTF values as computed from a lens design; (b) of actual measured MTF on a particular lens; and (c) to compare actual measurements with design predictions on the same lens.

Descriptors: (LENSES, PERFORMANCE (ENGINEERING)), (OPTICAL EQUIPMENT, SPECIFICATONS), OPTICAL PROPERTIES, LEAST SQUARES METHOD, STANDARDIZATION, RESOLUTION

HORNE, D.F.
OPTICAL PRODUCTION TECHNOLOGY
Adam Hilger, London (1972)

Chapter XI. Testing Optical Components presents a very complete review of the main optical testing techniques.

INGALLS, A.G.
AMATEUR TELESCOPE MAKING
Scientific American, Inc. N.Y. (1953)

In these books the following papers may be found:
R.W. Porter, "MIRROR MAKING FOR REFLECTING TELESCOPE" Vol. 1.
A.G. Ingalls, "THE PRISM OR DIAGONAL" (Newton Test), p. 52 Vol. 1.
A.G. Ingalls, "TESTING: FOUCAULT'S SHADOW TEST", p. 82, Vol. 1.
A.G. Ingalls, "HOW TO RECOGNIZE THE PARABOLOID ZONAL TESTING", p. 96, Vol. 1.
A.G. Ingalls, "TESTING AND FIGURING" (Foucault test for Lenses), p. 120, Vol. 1.
A.R. Kirkham, "THE RONCHI TEST FOR MIRRORS", p. 264, Vol. 1.
R.W. Porter, "NOTES ON THE RONCHI BAND PATTERNS", p. 268, Vol. 1.
A.R. Kirkham, "THE DIRECT FOCAL TEST FOR GREGORIAN SECONDARIES", p. 271, Vol. 1.
A.G. Ingalls, "THE DIFFRACTION RING TEST (STAR TEST)" p.428 Vol. 1.
A.W. Everest, "BACKWOODS PHILOSOPHY" (FOUCAULT TEST)", p. 70, Vol. 2.
J.H. King, "A QUANTITATIVE TEST FOR TELESCOPE MIRRORS" (RONCHI TEST, from Vol. 2.

W.A. Calder, "THE HARTMANN TEST", p. 109, Vol. 2.
H.H. Selby, "FLATS" (NEWTON), p.118, Vol. 2.
H.H. Selby, "NOTES ON THE OPTICAL TESTING OF ASPHERIC SURFACES" (FOUCAULT TEST FOR CONIC SURFACES), p. 132, Vol. 2.
H.A. Lower, "NOTES ON THE CONSTRUCTION OF AN F/1 SCHMIDT CAMERA (LOWER TEST), p. 410, Vol. 2.
BURCH, C.R. "SMALL PINHOLES" (FOR FOUCAULT TEST), p. 65, Vol. 3.
H.E.Dall, "A NULL TEST FOR PARABOLOIDS" p. 149, Vol. 3.
I.C. Gardner, "A SPHEROMETER FOR MEASURING RADII OF CURVATURE OF SMALL STRONGLY CURVED SURFACES" p. 200, Vol. 3.
G.D. Hanna, "A REFLECTING AUTOCOLLIMATOR FOR PRECISE MEASUREMENT OF PRISM ANGLES", p. 253, Vol. 3.
I.H. Schroader, "THE CAUSTIC TEST", p. 429, Vol. 3.

ITEK CORP.
"STUDY OF IMAGE-EVALUATON TECHNNIQUES"
Interim Engrg. Rept. No. 12 (1965)

The primary goal of this program is the development of a valid computational means for determining object to image relationships in photo-optical reconnaissance systems. Our attention is currently restricted to the lens- film combination. The investigation has been primarily based on linear transfer function, or spatial frequency, analysis. In the area of lens response, the basic linearity of the optical system makes this analysis valid, if not completely sufficient (e.g., veiling glare is not accounted for by the lens transfer function). In the areas of film response, nonlinear analysis must be resorted to in order to account for the fundamental nonlinearity attested to by the D-log E curve as well as for the much less well understood effects of finite chemical diffusion rate properties commonly called adjacency effects. Because of the many problems in film response analysis, is generally separable into lens, film, lens-film system, and computer programming categories. In essence, our experimental and theoretical studies in the lens, film and lens-film system areas are to provide the conceptual and practical foundations for a computer program that will make possible the calculation of object to image relationships in general lens film system.

Descriptors: AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, THEORY, OPTICS, PHOTOGRAPHIC IMAGES, MATHEMATICAL MODELS, PHOTOGRAPHIC LENSES, RECONNAISSANCE FILM, FUNCTIONS (MATHEMATICS), FEASIBILITY STUDIES, COMPUTER PROGRAMMING, PHOTOGRAPHIC EMULSIONS, RESOLUTION, STATISTICAL ANALYSIS
Identifiers: NTISDODXD

JOHNSON, B.K.
<u>OPTICS AND OPTICAL INSTRUMENTS</u>
Dover Publications, Inc. N.Y. (1947)

The following chapters are of some interest: II. Focal Length Measurement and VIII. Optical Glass: Its Working and Testing.

KINGSLAKE, R.
APPLIED OPTICS AND OPTICAL ENGINEERING
Academic Press, N.Y., 5 Vols. (1967)
The following chapters in Vols. 3 and 4 describe some optical testing procedures:
R.M. Scott, Chap. 2, Vol. 3. OPTICAL MANUFACTURING
R.R. Shannon, Chap. 5, Vol. 3 THE TESTING OF COMPLETE OBJECTIVES
A.W. Young, Chap. 7, Vol. 4 OPTICAL WORKSHOP INSTRUMENTS
K.M. Baird and G.R. Hanes, Chap. 9, Vol. 4 INTERFEROMETERS

LAGENBECK, P.
OPTICAL INSTRUMENTS AND TECHNIQUES
Oriel Press, 277 (1969)
Chapter: Advantages of Multipass Interferometry.

LINFOOT, E.H.
RECENT ADVANCES IN OPTICS
Clarendon Press, Oxford (1955)
This book has a very good theoretical analysis of the Foucault knife-edge test in Chap. II: The Foucault Test.

MAKSUTOV, D.D.
IZGOTOVLENIYE I ISSLEDOVANIYE ASTRONOMICHESKOY OPTIKI
(THE FABRICATION AND TESTING OF ASTRONOMICAL OPTICS)
Gostekhizdat Press, Moscow (1948)
No abstract provided.

MALACARA, D.
"TESTING OF OPTICAL SURFACES"
Ph.D. Thesis, The University of Rochester (1965)
This thesis contains a description of an automatic testing procedure for aspherical surfaces using the Ronchi test and the Murty interferometer.

MALACARA, D.
OPTICAL SHOP TESTING
(1978)
This book brings together descriptions of all tests useful in the optical shop for testing optical components and systems.

MARTIN, L.C.
TECHNICAL OPTICS
Pitman and Sons, Ltd., London (1960)
"The testing of Optical Instruments and the Study of Their Performance" in Vol. 2 contains a very complete description of the main optical testing techniques.

MC CAMY, C.S.
"PRECISION MEASUREMENT AND CALIBRATION: IMAGE OPTICS"
Nat. Bur. of Stand. Washington, Inst. for Basic Standards (1973)

The volume is one of an extended series which brings together the previously published papers, monographs, abstracts, and bibliographies by NBS authors dealing with precision measurement of specific physical quantities and the calibration of the related metrology equipment. The contents have been selected as being useful to the standards laboratories of the United States in racing to NBS standards the accuracies of measurement needed for research work, factory production, or field evaluation. The volume deals with image optics, including photography. It contains 62 reprints assembled in 4 sectons:

147 where, in a description of the method for determining refractive indices in the far ir, it is clearly stated that the interferometer be filled with air. Similarly, in the chapter on interference spectroscopy, far ir Michelson interferometers are only mentioned in passing even though it is now almost certain that the great majority of Michelson interferometers in practical use are working in this range. In this chapter, the problem of the great dynamic range needed in the observing system for observations of absorption spectra is briefly mentioned, but the only solution advanced is the elegant but practically proved method of limiting the spectral band pass by filters would seem to merit discussion.

A general criticism of he work is that many points the argument is unclear. An expert can see what is meant-though not explicitly written-but a beginning student would experience some difficulty. As an example, after describing how the Fizeau fringes in a Michelson interferometer can be removed by mirror adjustment so that a uniform field is observed, the author goes on to say that, by moving one of the mirrors lack parallel to itself, the fringes loose contrast. What fringes are meant? This lack of clarity is probably a consequence of the need to condense a great deal of information into a small book. The monograph, as it stands, can be recommended to workers in the field who will find occasional points badly covered or badly described, but who will find the breadth of coverage stimulating. A future second edition expanded and with the argument at some points rewritten could be a very useful work indeed, suitable for a wide range of readers.

STRONG, J.
<u>PROCEDURES IN EXPERIMENTAL PHYSICS</u>
Prentice Hall, Inc., N.Y. (1938)
A very good qualitative description of Newton's and Foucault's knife-edge tests and Ronchi test is found in Chap. II: Laboratory Optical Work.

STRONG, J.
<u>CONCEPTS OF CLASSICAL OPTICS</u>
W.H. Freeman, N.Y. (1958)
This book has some very interesting chapters and appendices relevant to optical testing: Chap. XIII. Images of Points by Single Surfaces (describes Foucault's and Gaviola's test). Appendix B: Interferometers by J. Dyson (describes some common path interferometers). Appendix C: The Koster's Double-Image Prism, by J.B. Saunders.

TAYLOR, H.D.
THE ADJUSTMENT AND TESTING OF TELESCOPE OBJECTIVES
Grubb, Parsons and Co., London (1946)
This book has a very good description of the star test of telescope objectives.

TEXEREAU, J.
HOW TO MAKE A TELESCOPE
American Museum of Natural History, Anchor Books, Doubleday (1957)
Chapters II and III have several sections concerning the testing of concave and plane mirrors.

TOLANSKY, S.
MULTIPLE-BEAM INTERFEROMETRY OF SURFACES AND FILMS
Clarendon Press, Oxford (1943)
Although optical testing is not specifically mentioned, this book contains very useful material indirectly relevant to this topic.

TWYMAN, F.
PRISM AND LENS MAKING
Hilger and Watts, Ltd., London (1957)
This book has the following very good chapters concerning optical shop testing. *Unfortunately this book is now out of print.*
Chap. 11: Testing Optical Work
Chap. 12: The Hilger Interferometers for Testing Prisms and Lenses
Chap. 14: Testing Optical Glass
Chap. 15: Large Obbject Glasses and Mirrors

U.S. DEPT. OF DEFENSE
Mil-HDBK-141 (1963)
A good review of the main tests is found in:
H. Ostbeg, Sec. 16, Applications of Physical Optics
H. Osterberg, Sec. 25, Production Phase Optical Tests

WOLF, E.
PROGRESS IN OPTICS
North-Holland, Amsterdam, 9 Vols. (1965)
The followng chapters in Vols. 4 and 5 describe some optical testing procedures:
D.R. Herriott, Chap. V, Vol. 4, p. 171, "Some Application of Lasers to Interferometry"
O. Bryngdahl, Chap. II, Vol. 4, p. 39, "Applications of Shearing Interferometry"
W.H. Steel, Chap. III, Vol. 5, p. 145, "Two Beam Interferometry"

21 LUPI

BATISHKO, C.R. and SHANNON, R.R.
"PROBLEM IN LARGE-PATH-DIFFERENCE LASER INTERFEROMETRY"
Appl. Optics, 11, 195 (1972)

As development of test tower instrumentation and of the LUPI continues, various problems receiving attention have disclosed peculiarities in the system.

One of these problems, a flickering of the interference fringes and an accompanying periodic loss of contrast, has recently been studied. As viewed on a TV monitor, the fringes appear to be of nearly uniform contrast but to vibrate at a moderate frequency (<100 cycles/sec). When the video tape is replayed in slow motion, the contrast is seen to vary approximately periodically in such a way as to give near -zero contrast once every three to five frames. (The actual rate is approximately 16 times sec.)

DE VANY, A.S.
"SUPPLEMENT TO: SOME ASPECTS OF INTERFEROMETRIC TESTING AND OPTICAL FIGURING"
Appl. Opt., 9, 1219 (1970)

No abstract provided.

HOUSTON, J.B., Jr., BUCCINI, C.J. and O'NEILL, P.K.
"A LASER UNEQUAL PATH INTERFEROMETER FOR THE OPTICAL SHOP"
Appl. Opt., 6, 1237 (1967)

No abstract provided.

MUNNERLYN, C.R.
"DIFFRACTION GRATING INTERFEROMETER"
Appl. Opt., 11, 1883 (1972)

This is an unequal path Twyman-type interferometer for testing optical surfaces, particularly at wavelengths in the IR. The beam divider is a reflection diffraction grating. The plus one order diffracts, reflects off of the test mirror, and returns to the grating. The zero order of the return beam and the minus one order of the incident beam interfere.

RANCOURT, J.D.
"INTERFEROMETRIC FRINGE ANALYSIS"
Opt. Shop Notebook, IX, 69 (1975)

Interferometric fringe data reduction has been done subjectively for years. The evaluation was done by eye so that the quality of optical components was established qualitatively. Large companies have utilized complex computers to get quantitative data, but these methods have been beyond the reach of the majority of optical shops. We show here that it is now possible to do this analysis with a minimum of optical equipment and a relatively inexpensive desk-top calculator.

The type of fringes we are concerned with are formed by an interferometer of the reference wavefront type (as opposed to the shearing interferometer), and they can be obtained from a wide variety of test configurations. these include the methods known as Fizeau, Twyman-Green, laser unequal path, scatterplate, and test plate, among others. In all of these configurations, a wavefront is generated which is assumed to be perfect. This reference beam and the beam which samples the test element are combined and interfere with one another to produce light and dark bands. A tilt is often introduced between the two beams in order to get fringes which are more or less straight. The tilt is mainly a convenience. With appropriate techniques, the patterns obtained without a tilt (bull's eye fringes) can also be analyzed, tough it is somewhat more complex and time consuming. A photograph is generally taken of the the fringe pattern in order to get a permanent record and to be able to study the fringes without the vibrations often associated with viewing them in realtime.

SHANNON, R.G. and SANGER, G.M.
"CURRENT STATUS OF THE MMT OPTICS"
Opt. Eng., 14, 544 (1975)

The Multiple Mirror Telescope, a joint University of Arizona and Smithsonian Astrophysical Observatory project, was first reported in this journal in 1972. The optics are in production, some complete, others near completion. Some of the ideas we used worked, others did not. This paper discusses the techniques actually used and how well they succeeded.

WOLLENSAK, R.J. and ROSE, C.A.
"FABRICATION AND TEST OF 1.8-METER-DIAMETER HIGH QUALITY ULE MIRROR"
Opt. Eng., 14, 539 (1975)

The purpose of this investigation was to determine the feasibility of producing large diameter, high quality optical surfaces similar to those that will be required for some of the planned orbital observing units such as the Large Space Telescope (LST). Current requirements for the Large Space Telescope require that a lambda/20 rms wavefront be produced at the Cassegrain focus. A reasonable distribution of error sources would, therefore, demand that the primary mirror be figured to a tolerance of lambda/64 rms on the surface. NASA hasa funded the iniial step toward demonstrating the ability to meet that requirement. An optical fabrication demonstration program was undertaken using an available 1.8 meter-diameter ULE monolithic mirror that was used had no central performation and was approximately 12 inches thick with 1-inch front and back plates. In order to accomplish this task, a variety of support and test equipment was designed and fabricated and the actual optical fabrication and test were conducted over a period of approximately' eight months. The results of this effort yielded a mirror with a surface quality of 0.015 wave rms of lambda/65.3. (lambda=632.8 nonometers.)

ZIELINSKI, R.J.
"UNEQUAL PATH INTERFEROMETER ALIGNMENT AND USE"
Opt. Engrg., 18, 479 (1979)

A step-by-step process for aligning an unequal path interferometer is given. The interferometer as an optical test tool is discussed, as are configurations for evaluating a variety of optical components and systems.

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ARNOLD, J.B., SLADKY, R.E., STEGER, P.J., and WOODALL, N.D.
"MACHINING NONCONVENTIONAL-SHAPED OPTICS"
Opt. Eng., 16, 347 (1977)

Nonconventional-shaped optics are being machined for use in laser optical system. The fabrication processes incorporate special- quality diamond tools and specially constructed turning machines. The shapes produced include axicons (connical-shaped mirrors), waxicons (a compound axicon with a "W" cross section), torics, and multifacet mirrors. Whereas conventional-shaped optics are very impractical to lap. The axicons annd waxicons produced were estimated to have surface straightness as good as 5 mu in (125nm), over 3 innches (76 mm) of lenghth, and angular accuracy as good as 2 a rc seconds. A toric mirror was estimated to deviate (peak to valley) from a best-fit radius by 4 mu in (100nm) over 2.25 innches (57 mm) of surface length.

BAKER, P.C., SONDERMANN, J.B. and SAITO, T.T.
"FINISHING OF PRECISION GENERATED METAL OPTICAL COMPONENTS"
Design Maufacture and Application of Metal Optics, 65, (1975)

Diamond turning and precision generation of aspheric metal surfaces has promoted a change in lapping techniques due to the extremely close figure tolerances and surface finishes that have been achieved. In order to polish the unusual aspheric figures, we utilized special tooling, diamond abrasive, and silicon oil and techniques which we will describe in detail. Our studies include small flat diamond turned samples of copper, electroplated cpper, electroplated silver, electroplated nickel and slver as well as large aspheres ssuch as an f/0.75, 35 cm diameter copper ellipse. Resultss from cleaning studies on flat samples using ultrasonics and vapor degreasers will also be summarized. Interferograms of wavefront distortion and analysis of focal volume will be included as well as 10.6 mum reflectivity and a summary of laser amage experiments.

BARKMAN, W.E.
"THE LINEAR MOTOR SLIDE DRIVE SYSTEM"
Union Carbide Corp., Fabrication Systems Dev. (1978)

Precison machine tools are designed and fabricated with a real deal of consideration given to maintaining as smooth and precise a motion as possible between the cutting tool and workpiece. Air bearing sides and spindles along with pneumatic isolation systems are used to eliminate many of the mechanical disturbances associated with other machine tools. Unfortunately, the slide drive mechanism used in most cases is the ball nut/lead screw which introduces vibration and slide positioning errors due to the mechanical gearing. To avoid these problems a linear-induction-motor slide drive system has been developed which has no mechanical coupling between the motor's stationary and moving members. When interfaced with a laser interferometer positon transducer, this drive system is capable of producng slide position accuracies of better than 3 microinches when driving a 1,000 lb. mass between 0 and 4 ipm. The paper describes this and other efforts that are continuing to extend the system capabilities to drive masses up to 10,000 lbs.

BENJAMIN, R.J.
"DIAMOND TURNING AT A LARGE OPTICAL MANUFACTURER"
Bell & Howell, Optical Divison (1978)

The development of precision machines for generating aspheric optical surfaces at Bell & Howell Company, which were the ancestors of many of today's diamond turning machines, is outlined together with present machine capability. A practical procedure for compensating for repeatable machine position errors based upon measurement of a "best-fit" sphere is described. Applications of diamond turning to reflective and transmissive (germanium and silicon) infrared optical elements are illustrated.

BENNETT, H.E., SOILEAU, M.J. and ARCHIBALD, P.C.
"DIAMOND-TURNED MIRRORS"
Presented to the 7th Annual Laser Induced Damage in Optical Materials Symposium, CO (1975)

No abstract provided.

BIRCH, K.G. and CUNNINGHAM, G.
"THE PRACTICAL REALIZATION OF A SET OF STANDARD REFERENCE LENSES"
Soc. Photo-Optical Instrumentaton Eng. (1977)

The National Physical Laboratory has sponsored fully toleranced optical designs of five standard reference lenses for the assessment of equipment used in measurement of the optica transfer function. The designs are briefly described, indicating the particular imaging characteristics that each lens simulates and the tolerances associated with each design if the theoretical performance level is to be achieved. The influence of those tolerances on the mechanical design of the lens mounts is indicated and the difficulties in manufacture arising from them discussed. Examples of three lens designs have been completed to date. The performance of two designs, measured both interferometrically and directly on an OTF measuring instrument, is compared with the theoretically predicted performance. The performance of the third design, a triple lens, has only been assessed interferometrically. A comparison of these initial measurements with theoretical performance is also presented. Progress in the construction of the other two lens designs is reported (1 Refs).

Descriptors: LENSES; OPTICAL DESIGN TECHNIQUES; MEASUREMENT STANDARDS; LIGHT INTERFEROMETRY; OPTICAL TRANSFER FUNCTION; OPTICAL INSTRUMENT TESTING

Identifiers: STANDARD REFERENCE LENSES; FULLY TOLERANCED OPTICAL DESIGNS; IMAGING CHARACTERISTICS; TOLERANCES; MECHANICAL DESIGN; TRIPLET LENS; OTF MEASUREMENT; INTERFEROMETRIC PERFORMANCE MEASUREMENT

BOHARCHE, J.J., GIH-HORNG, C., and MOORE, D.T.
"DESIGN OF A HIGH SPEED OPTICAL PRODUCTION LINE"
Optical Eng., 15 416 (1967)

The engineerng requirements for a high speed production line for optical elements have been investigated. The studies were based on a three-step process-diamond tubular tool generation, diamond pellet lapping and polishing with polyurethane bonded cerium oxide. Emphasis was placed on precision of one interference ring and an accuracy of three interference rings with respect to the desired radius of curvature. The lapping and polishing stages were designed to reduce the microstructure of the work while leaving the surface shape unaffected. At each stage of the process the surface figure was measured. A new testing technique was used to study and to quantify the microstructure of the lapped and polished surfaces. The microstructure was measured to 20 Angstroms peak-to-peak using a Scanning Fizeau Innterferometer.

BREHM, P.D.
"EVOLUTION OF A NUMERICALLY CONTROLLED DIAMOND TURNING SYSTEM"
Pneumo Precision, Inc., N.H. (1978)

This paper will trace the evolution and development of single point diamond tool precision machining equipment from a simple single axis machine to a two axis CNC/Interferometer controlled lathe for machining of contoured optical surfaces. The design criteria basic to such machines to control machine rigidity, friction, geometrical accuracy, vibration, temperature, and positioning accuracy will be discussed. Various surfaces and the machine configurations suitable for producing them are listed.

BUCHROEDER, R.A., ELMORE, L.H. and SHACK, R.V.
"THE DESIGN, CONSTRUCTION AND TESTING OF THE OPTICS FOR A 147-CM APERATURE TELESCOPE"
Arizona University, Tuscon, Arizona, Report No. NASA-CR-139486 (1972)

Geodetic optics research for the Air Force Cambridge Research Laboratories (AFCRL) is described. The work consisted mainly of the fabrication of the optical components for a telescope with a 152-cm-diam (60-in.) primary mirror masked down to 147-cm-diam for use by the AFCRL for a lunar ranging experiment. Among the achievements of this contract were the following: completion of the primary and secondary mirrors for a high-quality 147-cm- diam telescope system in eight months from the start of edging the primary: manufacture and testing of a unique center mount for the primary according to an AFCRL design that allowed for a thin-edged and therefore less-massive mirror; and development of a quantitative analysis of the wire test for calculating the departure of the mirror figure from the design figure quickly and accurately after each polishing 9step. This analysis method in conjunction with a knowledge of polishing rates for given weights and diameters of tools, mirror, and polishing materials should considerably reduce the polishing time required for future large mirrors.

Descriptors: ASTRONOMICAL TELESCOPES; LUNAR RANGEFINDING; OPTICAL EQUIPMENT; LUNAR RETROREFLECTORS; MIRRORS; POLISHING; SYSTEMS ANALYSIS

Identifiers NTISNASA

CASSATEVENS, J.M. and DAUGHERTY, C.E.
"DIAMOND TURNING OPTICAL SURFACES ON ELECTROLESS NICKEL"
Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee 37830

An explanation of the electroless nickel plating process is given and important metallurgical and mechanical properties of the plating are discussed. Optical applications of electroless nickel are described. Machinability tests were conducted with variations in types of plating. thickness of plating, types of stustrates, and heat treatment of the plating, results of the testing program are presented.

CHURCH, E.L., JENKINSON, H.A., and ZAVADA, J.M.
"MEASUREMENT OF THE FINISH OF DIAMOND-TURNED METAL SURFACES BY DIFFERENTIAL LIGHT SCATTERING"
Opt. Eng., 16, 360 (1977)

This paper discusses the measurement of the finish of diamond-turned surfaces by differential light scattering. Experimental scattering data are analyzed by electromagnetic theory to give the two-dimensional power spectral density of the surface roughness. These spectral densities are direct functional measures of the surface quality, and may be characterized in terms of topographic finish parameters. These parameters can then be used to specify surface finish, to predict scattering under a variety of conditions, and to aid in studies of other functional properties of these surfaces. Scattering spectra are separated into three groups corresponding to three classes of surface roughness: periodic tool marks give rise to discreet dirraction lines in the scattering spectrum and are characterized by their surface periods and their Fourier amplitudes. Random one- and two-dimensional roughness give rise to one- and two-dimensional continua underlying the diffraction lines and are characterized by band-liminted values of the rms surface heights and slopes, and transverse length parameters. Using HeNe light, vertical roughnesses are measured from a fraction of an Angstrom to several hundred Angstroms, for transverse spatial wavelengths from a fraction of a micron to several hundred microns. We review experimental techniques for making these measurements with emphasis on the scatterometer developed in our laboratory, which uses a fixed source-detector geometry and a rotating sample. Results are illustrated by a number of scattering spectra taken with this instrument.

CURCIO, M.E. and JOHNSON, F.E.
"NUMERICALLY - CONTROLLED (N/C) MACHINING OF INFRRARED OPTICS - TECHNOLOGY SURVEY"
AF Materials Laboratory IR-638-7 (1) (1977)

No abstract provided.

CURIO, M.E.
"OPTICAL CHARACTERIZATION PROGRAM FOR DIAMOND-TURNED ASPHERICS FOR INFRARED (IR) SYSTEMS USE"
Proc. SPIE, 159, 88 (1978)
Honeywell Electro-Optics Center, Lexington, MA 02173

The ability to successfully fabricate an optical element has as its bounds on contour accuracy and functional systems performance the level to which these features can be characterized via test methods. In addition, product saleability and satisfaction of specification must also be provided in a production-compatable optical evaluation program. The restrictions are even more severe in the case of a diamond-turned sample, particularly aspherics. The impact of slope errors, finish and sub-surface micro structure on the imageing properties of an element as a result of the diamond-turning micro structure on the imaging properties of an element as a result of the diamond-turning processing is to this point ill-defined and must become an important part of an overall characterization scheme. While a measure of the element Optical Transfer Fucntion (OTF) would provide proof of suitability in its production environment. this paper addresses an overall characterization program for diamond-turned elements for infrared-systems use which will provide specification verifications, systems performance parameters and production buy-off potential while remaining compatible th needs of production-level operation.

DECKER, D.L. and GRANDJEAN, D.J.
"PHYSICAL AND OPTICAL PROPERTIES OF SURFACES GENERATED BY DIAMOND-TURNING ON AN ADVANCED MACHINE"
Naval Weapons Center, China Lake, CA

A superprecision, two-axis, air-static bearing, diamond-turning machine of advanced design has been previously described at this Conference and is now operational. The microtopography and other physical characteristics of surfaces turned by this machine will be examined in detail. Some effects of machining parameters will be briefly discussed. The ability of this machine to turn surfaces with very small slope errors (less than 10^{-3}) and small rms roughness (approx. 10 A) is discussed with relation to the resulting optical absorption, scattering, and laser damage resistance. The characteristics of the machine which permit these high quality surfaces are identified, and some projections are given to the future application of diamond-turned optics at near infrared or visible wavelengths.

Key Words: ABSORPTION; DIAMOND-TURNING; SCATTERED LIGHT; SURFACE ROUGHNESS

DECKER, D.L., BENNETT, J.M., SOILEAU, M.J., PORTEUS, J.O., and BENNETT, H.E.
"SURFACE AND OPTICAL STUDIES OF DIAMOND-TURNED AND OTHER METAL MIRRORS"
Naval Weapons Center, China Lake, California 93555

Intercomparison of the optical properties of diamond-turned, evaporated and sputtered metal mirrors is made with specific reference to surface and bulk physical structure. In most applications, absorption and scattered light are important optical parameters. Both of these characteristics are directly related to surface microtopography which is a direct product of the finishing methods employed. For laser applications, the threshold for damage is also often critical. The properties influencing laser damage include suface microtopography, as well as bulk physical and chemical structure. Diamond turning, in addition to is very attractive manufacturing advantages, can produce optically superior components. Nearly intrinsic values of pulsed laser damage threshold and absorption have been measured on diamond- turned copper mirrors.

DOW, S.F.
"HOW TO MAKE LENSES AND TELL THE GOOD FROM THE BAD"
J. Opt. Soc., Am., 63, 1273 (1973)

Optical components are customarily manufactured by classical methods to tolerances of geometrical shape that far exceed those of most mechanical parts. Ingenious but practical test methods using apparatus of ordinary mechanical precision ahve been devised over the years to see and map surface shape errors of a few millionths of an inch. Methods such as the foucault knife edge, hartmann diaphragm, interference test-glass, and visual-target tests produced useful but quantitatively limited data.

These and other methods are described from the point of view of physical optics to show the interconnections and to show how newer methods and technology along with advances in lens design in the last decade have permitted major improvments in the speed, accuracy, and scope of optical measurement.

Descriptors: OPTICAL TESTING; OPTICAL WORKSHOP TECHNIQUES; REVIEWS; LENSES

Identifiers: LENSES; OPTICAL COMPONENTS; TOLERANCES; SURFACE SHAPE ERRORS; FOUCAULT KNIFE EDGE; HARTMANN DIAPHRAGM; INTERFERENCE TEST GLASS; VISUAL TARGET

EVANS, R.W., GALLAGHER, P., and RIMMER, D.A.
"THE DESIGN AND CONSTRUCTION OF A LARGE APERTURE OPTICAL SYSTEM USING HOLOGRAPHIC AND INTERFEROMETRIC TESTING TECHNIQUES"
Opt. and Laser Technol., 7, 203 (1975)

In the design and construction of a large aperture optical system problems were encountered in figuring the optical elements and in mounting them to achieve mechanical stability. The various optical tests which were used to help overcome these problems on a system comprising refracting, reflecting, and Mangin elements are described. Test plates, star tests, OTF, Twyman-Green, and holographic techniques were all used at some stage, and the application for which each was used and the resasons why it was considered the most suitable technique are discussed (7 Refs).

Descriptors: OPTICAL DESIGN TECHNIQUES; LENSES; OPTICAL INSTRUMENT TESTING; HOLOGRAPHY; LIGHT INTERFEROMETRY

Identifiers: DESIGN; CONSTRUCTION; LARGE APERTURE OPTICAL SYSTEM; INTERFEROMETRIC TESTING TECHNIQUES; OPTICAL ELEMENTS; MOUNTING; MECHANICAL STABILITY; OPTICAL TESTS; MANGIN ELEMENTS; STAR TESTS; TF; HOLOGRAPHIC TECHNIQUES; REFRACTING ELEMENTS; REFLECTING ELEMENTS; TEST PLATES; TWYMAN GREEN TECHNIQUE

FISHER, R.E., SMITH, W.J., ZIMMERMAN, J., YODER, P.R., and PARKS, R.E.
"PANAL DISCUSSION - OPEN FORUM ON OPTICAL SYSTEMS AND COMPONENT SPECIFICATIONS"
SPIE Proc., 181, 163 (1979)

The following is a transcript from a tape and every effort was made to retain accuracy, with only limited editing required.

FRENIERE, E.R. and ZIMMERMAN, J.
"SPECIFICATIONS FOR DIAMOND-TURNED SURFACES"
SPIE Proc., 181, 77 (1979)
Honeywell Electro-Optics Center, Lexington, Massachusetts 01273

The surfaces of diamond machined optics are described in terms of the spatial frequency of the errors. Certain of these error which are unique to diamond machined optics, such as, the highly correlated errors due to tool advance and the error due to machine centering uncertainty, are discussed in detail.

The imaging effects of the errors are derived. A framework for specifying diamond machined optics, based on the imaging effects is present.

HOFFMAN, R.A., LANGE, W.J., GOWAN, J.G., and MIGLIONICO, C.J.
"ION POLISHING AS A SURFACE PREPARATION FOR DIELECTRIC COATING OF DIAMOND-TURNED OPTICS"
SPIE Proc., 159, 54 (1978)

A technique to improve the adherence of multilayer dielectric coatings to diamond-turned copper mirror surfaces was developed. The method employs carefully controlled ion polishing, vacuum annealing, and "in situ" coating of the mirror substrates. It was found that ion polishing and substrates, with as little as 100A removed, prior to coating improved the film adhesion significantly. All of the samples prepared in this manner passed all of the standard LIM SPEC mechanical tests while control samples produced by conventional methods failed the tests. Additional coating evaluation such as reflectivity and laser damage threshold measurements at 10.6 micrometers, Auger analysis for contaminants in the films and at interfaces, SEM characterization, and x-ray energy dispersive analysis are also discussed.

JOHNSON, F.E.
DIAMOND TURNING AT HONEYWELL"
Proc. SPIE, 159 (1972)

The application of diamond turning technology has made it possible for Honeywell, who possesses limited conventional optical fabrication capability, to rapidly become its own supplier of lower-cost infrared optics for in-house production programs. The achievement was originally instigated by an AFML MM&T program and is part of a two-hase plan outliend as this symposium in 1976. Phase I of the plan called for Honeywell, entirely on its own funds, to acquire a diamond flycutter to initially become familiar with the process and finally to produce usable infrared flat mirrors. Although the cycle requried 10 months of learning and some machine improvments, significant cost savings are now being accrued from the production of scanning and flat mirrors for thermal imaging systems. Phse II or the plane was commenced in 1977 by AFML sponsorship of a program to transfer diamond contouring machine technology from government laboratories initially to Honeywell so that broader industrial usage of infrared aspheric optics could result. Also, an NV&EOL contract is reinforcing the plan by utilizing Air Force porgram results to build and test aspheric diamond turned lenses and mirrors for Army infrared applications. Contract results are being publicized through reports and briefings. Within the plan, Hoenywell is committing funds to obtain a 2-axis CNC contouring machine, the required optical metrology, and the temperature-controlled facilities. Because continued cost-saving success is expected from the aspheric capability, as has been demonstrated with the flycutter on flat infrared mirrors, Honeywell hopes to become a production optics supplier to the DoD/DoE community by contributing its systems, computer science, and optical testing expertise.

MANSELL, D.N. and SAITO, T.T.
"DESIGN AND FABRICATION OF A NONLINEAR WAXICON"
Opt. Eng., 16, 355 (1977)

This paper described the theory, design and fabrication of a complementary pair of cone-like mirrors which transform an annular collimated laser beam into a gaussian profiled collimated beam without obscuration.

The details of a simple computer algorithm are revealed which explain the numerical procedure for computing the coordinates of the mirror surfaces. Also discussed in the procedure to diamond turn the nonlinear surfaces using the development lathe at the ERDA Y12 Plant and the metrology of the first parts produced.

MILLER, D.M., HAUVER,G.H., CULVERHOUSE, J.N., and GREENWELL, E.N.
"DESCRIPTION OF A UNIQUE MACHINE TOOL PERMITTING ACHIEVEMENT OF ,15-A RMS DIAMOND-TURNED SURFACES"
Battelle, Pacific Northwest Laboratories, Richland, WA 99352

A new machine tool now in the final stages of developement at Battelle, Pacific Northwest Laboratories uses a unique tool motion to produce diamond-turned surfaces of exceptionally high quality. Copper surfaces of revolution have been produced with a 12.3 A rms surface finish and a contour accuracy of 75 nm.

The cutting tool is programmed to have in 4 nm increments along two axes: one linear (x) axis and one circular (Omega) axis. Exceptionally stiff and accurate control of the tool is possible with this "Omega-X" system. In conjunction with a unique thermally stabilized air bearing spindle and machine calibration equipment, the Omega-X system permits a significant advance in the fabrication of optical-quality surfaces.

MOSS, T.
PROCEEDINGS OF THE SOCIETY OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS, Vol. 115, "ADVANCES IN REPLACATED AND PLASTIC OPTICS"

The following topics were dealt with replication advances; replicated mirrors and aspheric surfaces; plastic optical components; testing and environmental considerations. 11 papers were presented, of which all are published in full in the present proceedings.

Descriptors: OPTICAL WORKSHOP TECHNIQUES; ASPHERICAL LENSES; LENSES; MIRRORS; PLASTICS; REPLICA TECHNIQUES

Identifiers: REPLICATION ADVANCES; REPLICATED MIRRORS; ASPHERIC SURFACES; PLASTIC OPTICAL COMPONENTS; TESTING; ENVIRONMENTAL CONSIDERATIONS; LENSES

OLSON, V.F. and LISALDA, J.W.
"REFLECTIVE MEASUREMENTS OF ALUMINUM DIAMOND TURNED SURFACES"
Hughes Aircraft Company, Canoga Park, California 91304 (1978)

This paper discusses the results of reflectance measurments in the 1 to 12 micrometer region for aluminum diamond turned surfaces.

PARKS, R.E., SUMMER, R.E., and STRITTMATTER, R.E.
"POLISHING SINGLE POINT DIAMOND TURNED MIRRORS"
OSA, SAN MATEO, (1977)

A method of removing the high frequency microripple from single point diamond machined mirrors has been developed. The process uses conventional hand polishing techniques and laps of sufficient rigidity to bridge the microripple yet soft enough not to scratch the metal mirror surface. Substantial material must be removed from the mirror surfaces in some cases and the surface figure may be degraded unless careful testing is done during the process. We present photographs showing the reduction in scattering and improvement in mirror surface roughness as the result of the polishing. Phase-contrast microphotographs also show that the polished surface is almost as free of mechanical defects (scratches and pits) as the original virgin turned metal surface.

PEARSON, J.W.
"PRECISION MACHINING COMMERCIALIZATION"
Lawrence Livermore Laboratory, Livermore, California (1978)

The potential for large DoD cost savings by fabricating optical parts using state-of-the-art precision turning techniques has reuslts in an Air Force Materials Laboratory program to commerciallize the technology, now largely within DOE contractor laboratories and production facilities. Maching process is become an extension of optical process requiring a melding of optical and machining disciplines, including cost trade off for part complexity and production volume. Differences in terminology and specification conventions are being resolved. The goal of the three-year commercialization program is to accelerate a technology diffusion for presently identified needs. The program will sponsor seminars and workshops, aid in procurement specification writing, provide shop floor assistance in tool performance testing and supply documentaiton of technology for individual reference. Program plans call for a partnership with selected industrial companies in commercializing state-of-the-art precision turning technology

SAITO, T.T., MILAM, D., BAKER, P., and MURPHY, G.
"1.06 MICROMETER 150 PSEC LASER DAMAGE STUDY OF DIAMOND TURNED, DIAMOND TURNED/POLISHED AND POLISHED METAL MIRRORS"
Lawrence Livermore Laboratory, Livermore CA (1975)

No abstract provided.

SAITO, T.T.
"MEASUREMENT OF FIGURE OF DIAMOND TURNED OPTICS"
<u>Opt. Shop Notebook, IX</u>, 39 (1975)

One of the most serious hurdles for diamond turning to overcome has been obtaining good optical figure. Optical flats have been machined to 1200 A peak-to-valley flatness over more than 90% of 13 cm diameter mirrors. Optical figure of 3000 A peak-valley has been obtained on a molybdenum water cooled flat mirror which was refurbished using diamond turning. Diamond turning lends itself well to the generation of toric optics. Method and results of measurement of toric optical figure will be presented.

SAITO, T.T.
"DIAMOND TURNNG OF OPTICS"
Opt. Eng., 15, 431 (1976)

Recent developments in diamond turning of optics are reviewed. Improved surface figure and surface finish have been achieve as well as metrology of the machined part. Reflectivities of diamond turned metals at various wavelengths are sumarized. Application of diamond turned optics include laser resonator mirrors, x-ray microscopes, x-ray telescopes, missile optics. and scanner mirrors. The technology looks especially promising for present infrared requirements since both reflective, refractive, and transmittive components can be fabricated.

Diamond turning of optics can be defined as the use of a diamond tool on a precision lathe under very precisely controled machine and environmental conditions to fabricate a finished optical component. The specific application of precision maching principles to diamond turning has been led by the Lawrence Livermore Laboratory (LLL), Livermore. Califronia and Union Carbide Y-12 Plant (Y-12), Oak Ridge Tennessee.

SAITO, T.T.
"DIAMOND TURNING OF OPTICS: PAST, PRESENT, EXCITING FUTURE"
Opt. Eng., 17, 570 (1978)

No abstract provided.

SEREGIN, A.G. and DENISYUK, G.V.
"ON THE POSSIBILITY OF MEASURING THE ABERRATIONS OF AN OBJECTIVE IN 'WHITE' LIGHT"
Sov. J. Opt. Technol., 42, 150 (1975)

The formation mechanism of the objective pattern in while light is investigated allowing for sphero-chromatic aberration. Schemes for measuring the aberrations and for calculating the polychromatic distribution are illustrated diagrammatically. Curves showing the form of polychromatic functions and photoactinic flux are given it is shown that energy distribution in the interference pattern with lateral chromatism enables interferometric measurements to be evaluated for various photoactinic flux distributions (7 Refs.).

Descriptors: ABERRATIONS; OPTICAL TESTING; LENSES; LIGHT INTERFEROMETRY

Identifiers: FORMATION MECHANISMS; OBJECTIVE PATTERN; WHITE LIGHT; POLYCHROMATIC DISTRIBUTION; POLYCHROMATIC FUNCTIONS; PHOTOACTINIC FLUX; LATERAL CHROMATISM; INTERFEROMETRIC MEASUREMENTS; SHPEROCHROMATIC ABERRATION

SHAGAM, R.N., SLADKY, R.E., and WYANT, J.C.
"OPTICAL FIGURE INSPECTION OF DIAMOND-TURNED METAL MIRRORS"
Opt. Eng., 16, (1977)

This paper demonstrates that the optical testing of diamond- turned surfaces is best accomplished by interferometry and not by tests which measure wavefront slope. Certain conditions regarding the interferometer configuration must be met in order to generate meaningful and accurate interferograms. A 40 cm diameter aperture modified

Mach-Zehnder interferometer mounted directly on the diamond-turning lathe to facility rapid testing of figure between fabrication cuts is described. Results for a spherical surface tested in a Twyman-Green interferometer and an off-axis parabola tested in the Mach- Zehnder interferometer are illustrated.

SLADKY, R.E. and DEAN, R.H.
"OPTICAL MEASUREMENTS OF SURFACE QUALITY AND FIGURE OF DIAMOND-TURNED MIRRORS"
Union Carbide Corporation, Oak Ridge Tennessee, Y-DA-6328 (1975)
No abstract provided.

SOLID, J.E., SLADKY, R.E., REICHELT, W.H., and SINGER, S.
"SINGLE-POINT DIAMOND-TURNED COPPER MIRRORS: FIGURE EVALUATION"
Appl. Opt., 15, 1656 (1976)
No abstract provided.

SOLLID, J.E. and SLADKY, R.E.
"EVALUATION OF SIGNLE-POINT DIAMOND-TURNED COPPER MIRRORS FOR THE LOS ALAMOS SCIENTIFIC LABORATORY EIGHT-BEAM CO_2 LASER: HELIOS"

This paper describes the best large-aperture single-point diamond-turned copper mirrors currently available. The state-of-the-art is progressing rapidly. At present, for 400-mm diam, f/16.5 spherical surfaces, the peak-to-valley figure can be held to two visible fringes in a center of curvature test, and the surface roughness is better than 50 nm peak-to-valley.

Since the time of Galileo attempts have been made to machine optical components. With very few exceptions these attempts have failed. Recently, however, much careful attention has been paid to the numerous fine details such as vibration isolation, uniformity of spindle and tool drive, temperature control, tool sharpness, etc. Components of infrared quality are being produced in large numbers. The advantages of machined optics are a generally lower price, a higher production rate, a higher damage threshold (on the order of 11 J/cm^2, the intrinsic limit, for 1-ns, 10 micrometer pulses), and greater resistance to corrosion and tarnishing than can be achieved through conventional optical production. It is the combination of these advantages which made single-point diamond-turned (SPDT) optical components a key element in the current and projected Los Alamos Scientific Laboratory (LASL) CO_2 laser systems. There are two operating large pulsed CO_2 lasers at LASL; the TBS or Two-Beam System, and Helios, the Eight-Beam System. Helios has a nominal energy of 10kJ at 1 ns, while the TBS has a nominal energy of 2.5 kJ at 1 ns. The Antares CO_2 laser at LASL will have an energy of 10^5 J in 1 ns and consist of 6 beams of 12 segments, each of which is essentially an independent beam train. In addition to numerous smaller optics, a single segment of the beam train will contain the nine elements with a characteristic diameter of 40 cm or larger. There will be 72 such beam trains and 1500 elements. Completion of the laser is cheduled for 1982. Timely and reliable fabrication will be essential. Thus, signle-point diamond turning forms an integral part of the CO_2 laser fusion effort.

STOVER, J.C.
"CHARACTERIZATION OF SMOOTH MACHINED SURFACES BY LIGHT SCATTERING"
Appl. Opt. 1975

No abstract provided.

WILLIAMS, T.L.
PROCEEDINGS OF THE SOCIETY OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS, Vol. 109 "ADVANCES IN OPTICAL PRODUCTION TECHNOLOGY"

The following topics were dealt with Optical materials; generation, smoothing and polishing; centering, edging and cementing; inspection and testing; aspherics and replication. Thirteen papers were presented. All of which are published in full in the present proceedings.

Descriptors: OPTICAL WORKSHOP TECHIQUES; OPTICAL TESTING; OPTICAL MATERIALS; LENSES; ASPHERICAL ENSES

Identifiers: OPTICAL MATERIALS; GENERATION; SMOOTHING; POLISHING; CENTRING; EDGING; CEMENTING; INSPECTION; TESTING; ASPHERICS; REPLICATION; OPTICAL PRODUCTION TECHNOLOGY

23 ASPHERES

BIRCH, K.G., and GREEN, F.J.
"INTERFEROMETRIC TESTING OF ASPHERIC SURFACES"
Nat. Phys. Lab., Teddington, England, Rept. No. OP MET 12

Discussed laterial shearing interferometry, an adaption of a Twyrian Green interferometer and grazing incidence interferometry for the testing of aspheric surfaces of optical components.

Discriptors: INTERFEROMETRY LIGHT; LENSES ASPHERICAL; MIRRORS

Identifiers: INTERFEROMETRIC TESTING; ASPHERIC SURFACES; LATERAL SHEARING INTERFEROMETRY; TWYRIAN GREEN INTERFEROMETER; GRAZING INCIDENCE INTERFEROMETRY; OPTICAL COMPONENTS

CARTON, N.D.
"REPLICATED SCHMIDT PLATES-THEIR TESITNG AND PERFORMANCE CALCULATION"
Proceedings of the Society of Photo-Optical Instrumentation Engineerings, Vol. 115. Advances in Replicated and Plastic Optics 46-50 (1977)

The fabrication of aspheric elements by means of replication has become a very important method of supplying otherwise difficult to produce components. The Schmidt corrector plate is a typical example. The major benefit being projection TV for the consumer market. However, prior to this it is necessary to develop an objective test method. The author describes a laser ray trace method of measuring the aspheric profile to +or- 5 mu and subsequently using the derived coefficients to calculate the system M.T.F. Using this as the quality criteria an objective test method has evolved. The systems shortcomings are discussed and it is concluded that a useful production test method has been developed (2 Refs.).

Descriptors: ASPHERIC LENSES; OPTICAL ELEMENTS; REPLICA TECHNIQUES; OPTICAL WORKSHOP TECHIQUES; OPTICAL TESTING; OPTICAL PROJECTORS

Identifiers: TESTING; PERFORMANCE CALCULATIONS; FABRICATION; ASPHERIC ELEMENTS; REPLICATIONS; PROJECTION TV; LASER RAY TRACT METHOD; ASPHERIC PROFILE; QUALITY CRITERIA; SYSTEM MTF

CLARKE, J.A.
"ASPHERIC MIRROR OPTICAL SYSTEMS FOR THE INFRARED"
2nd International Conference on Low Light and Thermal Imaging, 18 (1979)

As part of the Philips programme to develop the pyroelectric vidicon (P.E.V) tube, the author has investigated possible optical systems. It was found that there were no suitable lenses available that would allow the P.E.V. to be used for long range applications. Using an overscanned 18 mm diameter target in the P.E.V. tube, resolutions of 0.5 m rad, or better, require lenses with focal lengths greater than 150 mm, with relative aperatures at least F/1 and preferably F/0.7 in order to detect temperature differences of 0.2 degreesc. An important requirement is that the optical system must be capable of being produced in quantity at a reasonable price, and that it should be as lightweight as possible. Such a lens would also be useful in systems employing mechanical scanning where similar resolution is required. Lenses of this type are used to illustrate various aspects of the design, manufacturing and testing programme (1 Ref.).

Descriptors: LENSES; INFRARED DETECTORS; MIRRORS
Identifiers: PYROELECTRIC VIDICON; LENSES; DESGN MANUFACTURING; TESTING; IR ASPHERIC MIRROR OPTICAL SYSTEMS

CURCIO, M.E.
"EVALUATION OF LOW-SCATTER TECHNOLOGY FOR ASPHERIC METAL MIRRORS"
Proceedings of the SPIE, 65 (1976)

An evaluation of the off-specular scatter from a metal mirror is required for those radiometric systems where high off-axis rejection is achieved through low-scatter primary optics. This paper addresses the testing procedures for determination of the bi-directional reflectance distribution function (BRDF) at 10.6 micrometer, handling techniques for the preventation of degraded mirror performance through contamination, and the low-scatter performance achieved by the current fabrication technology for large, aspheric samples. The statistics of mirror surface sampling is also presented, as well as the distribution of the resultant measurements for a significant sampling of the surface area. The latter are used to demonstrate the impact that various type of surface imperfections have on low-scatter performance, as well as indicate typical behavior for the better low-scatter mirrors. These statistics also indicate that best performance that can be anticipated under the present technology once these imperfections are eliminated.

DE VANY, A.S.
"LASER ILLUMINATED DIVERGENT BALL BEARING SOURCES"
Appl. Opt. 13, 457 (1974)

Gives details of autocollimating arrangements using laser illumination of a reflecting ball for figuring parabolic mirrors and aspheric lenses. Examples and interpretations of inside-of-focus ronchigrams or lateral-sheared interferograms fringe patterns are given. Applikcation of reflecting ball sources using a tuned laser to check spherochromatic aberration is suggested (4 Refs)

Descriptors: LIGHT SOURCES; LIGHT INTERFEROMETRY; TELESCOPES; OPTICAL INSTRUMENT TESTING; LENSES; LASER BEAM APPLICATIONS; ABERRATIONS
Identifiers: DIVERGENT BALL BEARING SOURCES; AUTOCOLLIMATING ARRANGEMENTS; LASER ILLUMINATION; PARABOLIC MIRRORS; ASPHERIC LENSES; TUNED LASER; SPHEROCHROMATIC ABERRATION; INSIDE OF FOCUS RONCHIGRAM;

LATERAL SHEARED INTERFEROGRAM FRINGE
PATTERNS

DIL, J.G., GREVE, P.F., and MESMAN, W.
"MEASUREMENT OF STEEP ASPHERIC SURFACES"
Appl. Opt., 17, 553 (1978)

A reference surface is first obtained by measuring the asphericity as a function of angle with the asphere placed on top of a spindle rotating with high accuracy. The measured displacements are compared with the theoretically expected values using a computer program and in this way the aspheric shape may be meausred with a precision of 0.1 mum. In the second part of the procedure the physical reference surface is illuminated and the reflected wave front is stored in a hologram in a Twyman-Green arrangement. The holographic comparison test results in a measuring error less than 0.1 mum. In the present paper the method is applied to 0.7 cm diameter aspheres having a total asphericity of 250 mum. But it can be extended to shapes as large as 5 cm (4 Refs.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; HOLOGRAPHIC INTERFEROMETRY

Identifiers: REFERENCE SURFACE; MEASURED DISPLACEMENTS; ASPHERIC SHAPE; REFLECTED WAVE FRONT; HOLOGRAM; HOLOGRAPHIC COMPARISON TEST; STEEL ASPHERIC SURFACE MEASUREMENT; TWYMAN GREEN ARRANGEMENT; LENS TESTING; HOLOGRAPHIC INTERFEROMETRY

DUBOVIK, I.A., DYAGILEVA, A.V. and KRIVOVYAZ, A.L.
"OPTICAL SYSTEMS OF INTERFEROMETERS FOR TESTING ASPHERICAL SURFACES"
Sov. J. Opt. Technol., 44, 712 (1977)

This paper considers modifications of the measuring and comparison arms of interferometers for testing aspherical components of moderate diameter such as concave parabolic mirrors having a large aperture, sphero-parabolic, sphero-hyperbolic and plano-elliptical lenses. Design calculation results and the aberration characteristics of the optical elements are present (2 Refs).

Descriptors: LIGHT INTERFEROMETERS; OPTICAL TESTING; MIRRORS; ABERRATIONS; ASPHERICAL LENSES

Identifiers: ABERRATION CHARACTERISTICS; INTERFEROMETER MODIFICATIONS; ASPHERICAL COMPONENTS TESTING; LARGE APERTURE CONCAVE PARABOLIC MIRRORS; SPHEROPARABOLIC LENSES; SPHEROHYPERBOLIC LENSES; PLANOELLIPTICAL LENSES; INTERFEROMETER OPTICAL SYSTEMS

DUKHOPEL, I.I., KONSTANTIONOVSKAYA, N.V. and FEDINA, L.G.
"METHODS OF TESTING THE SHAPE OF ASPHERICAL SURFACES OF ROTATION"
Sov. J. Opt. Technol., 42, 416 (1975)

In a review of methods both discrete and one-step testing methods are discussed. The use of a spherometer for convex surfaces and for aspheric surfaces with only small deviation from flatness is described and a scheme for dividing the surfaces into zones in the case of large-size ground components using a contact spherometer on each zone is also discussed. The suspended sphere used with autocollimation telescope technique and a method of testing surfaces in spherical coordinates are described. Five systems for non-contacting testing are shown schematically and their accuracies discussed. Interference methods for one-step testing of second-order surfacesa of rotation are considered with particular attention to testing of anaberration points, compensation methods and holographic methods. Several optical schematics are given for various surface testing modes. Aspheric proof glasses are briefly considered (63 Refs.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; REVIEWS

Identifiers: ASPHERICAL SURFACES OF ROTATION; SPHEROMETER: ANABERRATION POINTS; COMPENSATION METHODS; HOLOGRAPHIC METHODS; SHAPE TESTING METHODS; NONCONTACTING TESTING; INTERFERENCE METHODS

FISCHER, R.E.
"NULL-LENS MAPPING ERRORS"
Optical Soc. America, Washington (1971)

When a center-of-curvature null lens is used to test an aspheric mirror, two errors may occur. The first is a nonlinear mapping between the mirror surface and the interferogram interpretation. Predicted and experimental results are shown. The second error is that of distortion, and occurs when the null lens is used as a projection lens to form an image of the mirror superimposed on the interferogram. This can cause the image of the edge of the mirror and the edge of the fringe pattern not to coincide. Examples are shown. Similar problems with divergent lenses are discussed. Solutions of the problem of null-lens mapping errorrs are presented.

Descriptors: MIRROR; LENSES

Identifiers; NULL LENS MAPPING ERRORS; CENTRE OF CURVATURE NULL LENS; ASPHERIC MIRROR; INTERFEROGRAM; DISTORTION; OPTICAL TESTING; PROJECTION LENS; MIRROR EDGE; FRINGE PATTERN; DIVERGENT LENSES

GOODELL, J.B. and MUFFOLETTO, C.V.
"OFF-AXIS CORRECTOR FOR A PARABOLIC MIRROR"
Optical Soc. America, Washington (1972)

The presentation describes the design, fabrication, mounting, and testing of a triplet lens system which corrects aberrations from off-axis beams. Two off-axis angles of interest are 6.896 degrees and 6.526 degrees. The occur through diffraction of the KMG (2796 AA) and HMG (2803 AA) lines, respectively. The F/10 parabola has approximately a 678-MM focal length. Mechanical design required that the corrector has a length of about 40 MM. Thus, all elements are closely spaced. The spherical surfaces are co-axial with the parabola but required truncation 25 MM above the optic axis. This, together with close optical tolerance in order to achieve a less than 5-mu spot width, imposed severe cutting and ;mounting problems. The ultraviolet wavelengths required special testing procedures.

Descriptors: MIRRORS; ABERRATIONS OPTICAL; OPTICAL SYSTEMS

Identifiers: PARABOLIC MIRROR; DESIGN FABRICATION; MOUNTING; TESTING; TRIPLET LENS SYSTEM; ABERRATIONS; CLOSE OPTICAL TOLERANCE; CUTTING; OFF AXIS CORRECTOR; KMG 2796 ANGSTROMS LINE; KMG 2803 ANGSTROMS LINES; UV

HORNE, D.F.
"OPTICAL PRODUCTION TECHNOLOGY"
Adam Hilger, London, England (1972)

The topics discussed include grinding and polishing; single surface working; optical tools; dioptric surfaces; spectacle lense; prisms and flats; aspherical surfaces; component testing; surface coatings; fibre optics; electrooptics and optoelectronics

Descriptors; OPTICAL WORKSHOP TECHNIQUES
Identifiers: GRINDING; POLISHING; SINGLE SURFACE WORKING; OPTICAL TOOLS; DIOPTRIC SURFACES; SPECTACLE LENSES; PRISMS; FLATS; ASPHERICAL SURFACES; COMPONENT TESTING; SURFACE COATINGS; FIBRE OPTICS; ELECTROOPTICS; OPTOELECRONICS

HOUSE, C. and STEELE, N.
"EVALUATION OF INFRARED SYSTEMS"
IPC Sci. and Technol. Press, England (1976)

The manufacture of lenses and single components having either flat or aspheric reflective surfaces requires methods of testing. The method used for lenses is that of the line spread function, flatness is measured using either the Fizeau or Twyman and Green interferometers,and a linear transducers and recorder are employed with aspherical surfaces. The methods are discussed (2 Refs.).

Descriptors; INFRARED IMAGING; OPTICAL TESTING; ASPHERICAL LENSES; LIGHT INTERFEROMETRY; EVALUATION
Identifiers; LENSES; TESTING; LINE SPREAD FUNCTION; FLATNESS; INTERFEROMETERS; LINEAR TRANSDUCER; ASPHERIC SURFACES; IR

KARLIN, O.G. and SYUTKIN, V.A.
"THE USE OF SPHERICAL AND ASPHERICAL TEST GLASSES FOR INSPECTING ASPHERIC SURFACES"
<u>Sov. J. Opt. Technol., 39</u>, 156 (1972)

Experience in the use of interference methods for inspecting lenses with aspherical surfaces is described. The most efficient interferometer designs for each type of surface being measured are given. The calculations associated with these measurements are presented. (1 Ref.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES
Identifiers: ASPHERIC LENSES TESTING; SPHERICAL TEST GLASSES; ASPHERICAL TEST GLASSES; INTERFERNECE METHODS

KARLIN, O.G., LIPOVETSKIY, L.YE., and SYUTKIN, V.A.
"MEASUREMENT OF ASPHERICS ON AN IZS-7 SPHEROMETER"
<u>Sov. J. Opt. Technol., 39</u>, 220 (1972)

The advantages of the IZS-7 spherometer over the old measuring techniques employing gauge rings and indicators are reported. The measures, which must be taken in order to realize the spherometer advantages and to ensure a measurement accuracy of 1 mum under production-line conditions, are listed (1 Ref.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; OPTICAL INSTRUMENTS

Identifiers: IZS-7 SPHEROMETER; ASPHERICS MEASUREMENT; PRODUCTION LINE CONDITIONS

KHARITONOV, A.I., GORSHKOV, V.A., and SIMONOVA, E.S.
"ONE SOME METHODS OF TESTING ASPHERICAL WAVEFRONTS BY MEANS OF A SHARING INTERFEROMETER"
Sov. J. Opt. Technol., 43, 439 (1976)

An analytical approach is presented for the construction of the interference field as a function of the initial parameters of the set-up. Results of calculations of interference fields are shown diagramatically and curves are shown of theoretical and calculated aberrations of a shearing interferogram of a parabolic surface. Variation of the fringe pattern during polishing is considered (7 Refs.).

Descriptors: OPTICAL TESTING; ABERRATIONS; LIGHT INTERFEROMETERS; ASPHERICAL LENSES

Identifiers: TESINT; ASPHERICAL WAVEFRONTS; SHARING INTERFEROMETER; INTERFERENCE FIELD; ABERRATIONS; PARABOLIC SURFACE; POLISHING

KLINGSPORN, P.E.
"LASER INTERFEROMETRIC MEASUREMENT OF SPHERICAL SURFACE CONTOURS"

A laser interferometer was made operational for alignment of highly reflective spheres in a laser surface inspection system and for semi-automated measurement of roundness and waviness amplitude of the spherical surfaces. The non-contact interferometric measurements of roundness agree well with conventional measurements made with a stylus. The theoretical foundation was developed for a computer program to perform semi-automated measurement of waviness wavelength associated with the measured waviness amplitude. Theory was developed for using the interferometer to position the center of a sphere on a rotation axis when the laser beam is accessible to only one-quarter revolution of the spherical surface about this axis.

Descriptors: INTERFEROMETERS; INSPECTION; LASERS; OPTICS; SPHERES; SURFACES

Identifiers: ERDA/440300; NTISDE

KOLOMIITSOVA, T.S. and KONSTANTINOVSKAYA, N.V.
"ERRORS OF PROOF GLASS SUPERPOSITION METHOD FOR TESTING CONVEX SPHERICAL SURFACES"
Sov. J. Opt. Technol., 44, 1 (1977)

An analysis is presented of the sources of errors in the Saunders method (1954). A distinction is made between errors in local and zonal defect testing and the error in measuring astigmatism. It is concluded from experimental results that for convex surfaces of diameter up to 700 nm local defect errors are within 0.1 fringes and astigmatism errors between 0.25 and 0.35 fringes (4 Refs.).

Descriptors: OPTICAL TESTING; LENSES; MIRRORS

Identifiers: PROOF GLASS SUPERPOSITION METHOD; TESTING CONVEX SPHERICAL SURFACES; ERORS; SAUNDERS METHOD; ZONAL DEFECT TESTING; ASTIGMATISM; LOCAL DEFECT ERRORS

LAMBRECHT, C.R.
"ASPHERIC OPTICAL MANUFACTURING"
CRL, Inc., Highland Park, Illinois 60035

The manufacture of aspheric optical surfaces presents both technical difficulties and unique opportunities. Military systems will see increasing use of the aspheric optical surface due to improved function and reduced system cost.

This paper first summarizes the strengths and weaknesses of present diamond turning technology. The requirements of manufacturing precision aspherics in sufficient volume to be cost effectve are shown in terms of the turning, polishing and gaging machines necessary for production. The remainder of the paper discloses how machine control features using programmed micro-electronics allows a completely new approach to surfacing precision aspherics.

LUKIN, A.V., MUSTAFIN, K.S., and RAFIKOV, R.A.
"INSPECTING THE PROFILE OF ASPHERICAL SURFACES WITH THE AID OF ONE-DIMENSIONAL SYNTHESIZED HOLOGRAMS"
Sov J. Opt. Technol., 40, 398 (1973)

The title subject is discussed and examples of interference patterns obtained by such holograms for surfaces of rotation and cylindrical surfaces are shown. It is concluded that the method is very useful in manufacture of components with no symmetry axes (2 Refs.).

Descriptors: ASPHERICAL LENSES; OPTICAL TESTING; HOLOGRAPHY
Identifiers: INTERFERENCE PATTERNS; SURFACES OF ROTATION; CYLINDRICAL SURFACES; ASPHERICAL SURFACE PROFILE INSPECTION; ONE DIMENSIONAL SYNTHESIZED HOLOGRAMS; COMPONENT MANUFACTURE

MALACARA, D.
"GEOMETRICAL RONCHI TEST OF ASPHERICAL MIRRORS"
Appl. Opt., 4, 1371 (1965)

A method for calculating the geometrical Ronchi pattern of any aspheric mirror with the point source at any point along the optical axis is described. If a mirror gives a Ronchi pattern that is different from the one calculated, the deviations of this mirror from its ideal shape can be found.

MALACARA, D., and CORNEJO, A.
"NULL RONCHI TEST FOR ASPHERICAL SURFACES"
Appl. Opt., 13, 1778 (1974)

Proposes a Ronchi ruling with calculated curved lines the curvature of which compensates for asphericity of the test surface and thereby produces straight fringes of constant thickness which are more easily matched during the figuring process than the fringes of the normal Ronchi test. A monochromatic point source (Laser) is necessary for the proposed test. results for a paraboloidal mirror aRe given (3 Refs).

Descriptors: OPTICAL INSTRUMENT TESTING; LIGHT DIFFRACTION; DIFFRACTION GRATINGS; ASPHERICAL LENSES; MIRRORS

Identifiers: NULL RONCHI TEST; ASPHERICAL SURFACES; FIGURING PROCESS; MONOCHROMATIC POINT SOURCE; PARABOLOIDAL MIRROR; OPTICAL TESTING

MALACARA, D., and JOSSE, M.
"TESTING OF ASPHERICAL LENSES USING SIDE BAND RONCHI TEST"
Appl. Opt., 17, 17 (1978)

It was shown in an earlier paper by Malacara and Cornejo that holographic principles could be used with advantage to device a null-Ronchi test for aspheric surfaces. This technique becomes specially useful when it is applied to test aspheric lenses made in large quantities. A prototype of the lens may be tested with any other method, even if it is very time consuming. Since only one lens is going to be made. Then, this lens could be used to test quickly all subsequent lenses with the method described here.

MCAULIFFE, C.E.
"INTERFEROMETRIC TEST OF AN F/8, 24-INCH (60.96 CM) DIAMETER PARABOLOIDAL MIRROR IN THE ATMOSPHERE"
Opt. Eng., 12, 113 (1973)

A 24-inch (60.96 cm) paraboloidal mirror having a vertex radius of curvature of 32 feet (9.75 m) was tested on-axis with a laser interferometer in a normal atmosphere. A compensating null lens corrected the spherical aberration. Simultaneous observation of the fringe pattern and point spread function produced consistent, high quality interferograms. The residual optical path differences obtained from ten interferograms were averaged. Analytically removing astigmatism present in the system produced a residual root-mean-square optical path difference of 0.014 of the wavelength of the light. The coma amplitude measured was 0.04 of a wavelengths. The computed modulation transfer function at the mid-spatial frequency with astigmatism analytically removed is 0.002 below at a diffraction limited system (4 Refs.).

Descriptors: MIRRORS; OPTICAL TESTING; LIGHT INTERFEROMETRY; ABERRATIONS; ASTRONOMICAL TELESCOPES; ASTRONOMICAL TECHNIQUES

Identifiers: PARABOLOIDAL MIRROR; LASER INTERFEROMETER; COMPENSATING NULL LENS; SPHERICAL ABERRATION; FRINGE PATTERN; POINT SPREAD FUNCTION; RESIDUAL OPTICAL PATH DIFFERENCES; ASTIGMATISM; MODULATION TRANSFER FUNCTION; COMA AMPLITUDE

MOBSBY, E.
"TESTING PARABOLIC MIRRORS WITH INVERSE PARABOLIC GRATING"
Astronomy: J. Wessex Astron. Soc., 1, 12 (1973)

No abstract provided.

PURYAYEV, D.T.
"A QUALITY CONTROL TECHNIQUE FOR CONVEX ELLIPTICAL PARABOLIC AND HYPERBOLIC SURFACES OF SIMPLE LENSES"
Sov. J. Opt. Technol., 38, 684 (1971)

Discusses a quality control techique for testing aspehrical second-order surfaces of simple lenses in which the first surface is convex and the second is flat. The method is based on autocollimation of the paths of rays reflected from the surface being inspected (5 Refs.).

Descriptors: LENSES ASPHERICAL; OPTICAL INSTRUMENT TESTING
Identifiers: QUALITY CONTROL TECHNIQUE; CONVEX ELLIPTICAL; PARABOLIC; HYPERBOLIC SURFACES; SIMPLE LENSES; AUTOCOLLIMATION

PURYAYEV, D.T.
"COMPENSATOR FOR INSPECTING THE QUALITY OF LARGE DIAMETER PARABOLIC MIRRORS"
Sov. J. Opt. Technol., 40 (1973)

A compensator is described for the tital application, in the form of a single meniscus lens with a concave hyperbolic or parabolic surface, which can be used for parabolics up to 24 m focal length as well as for near parabolic hyperbolic surfaces. Diameter is less than 200 mm. Theoretical analysis of the geometry is given. Examples of application to mirrors with diameters in the range 1-6 m are given (9 Refs.).

Descriptors: OPTICAL TESTING; MIRRORS; LENSES
Identifiers: SINGLE MENISCUS LENS; PARABOLIC SURFACE; MIRRORS; GEOMETRY; QUALITY; LARGE DIAMETER PARABOLIC MIRRORS; COMPENSATOR; CONCAVE HYPERBOLIC SURFACE

PURYAEV, D.T.
"A UNIVERSAL LENS COMPENSATOR FOR INSPECTING THE QUALITY OF ASPHERICAL SURFACES"
Sov. J. Opt. Technol., 42, 585 (1975)

The optical system and range of application of a new type of compenstor for interference testing of astronomical mirrors is described in the basic properties of the compensator discussed in some detail. It consists of three lenses separated by air gaps and the relevant parameters for different light sources are tabulated. Parameters of parabolic, hyperbolic, and elliptical surfaces are various apertures to which the compensator is applicable are listed. Accuracy of the compensator may be checked with a Twyman-Green interferometer (2 Refs.).

Descriptors: OPTICAL TESTING; ASTRONOMICAL TELESCOPES; MIRRORS; LIGHT INTERFEROMETRY; LENSES
Identifiers: UNIVERSAL LENS COMPENSATOR; ASPHERICAL SURFACES; OPTICAL SYSTEM; INTERFERENCE TESTING; ASTRONOMICAL MIRRORS; ELLIPTICAL SURFACES; QUALITY INSPECTION; CASSEGRAIN TELESCOPES; TWYMAN-GREEN INTERFEROMETRY; PARABOLIC SURFACE; HYPERBOLIC SURFACE

RANDAL, C.M. and DOWLING, J.M.
"EVALUATION OF PARABOLIC OPTICS FOR THE AEROSPACE LAMELLAR GRATING INTERFEROMETER"
Aerospace Corp., El Segundo, California Lab. Operations,
Report No. TR-0200 (9260-01)-5 (1969)

The Czerny-Turner collimating system used in the Aerospace lamellar grating interferometer is shown to lead to significant instrumental line broadering. This system is compared with an off-axis parabolic mirror system, and the following conclusions are reached. (1) The instrumental line broadening of the parabolic mirror system will be an order of magnitude smaller than for the Czerny-Turner system. (2) The coma of the parabolic mirror system is negligible. (3) The wavefront distortion of the parabolic mirror system is less than that of the Czerny-Turner system.

Descriptors: INTERFEROMETERS; COLLIMATORS; MIRRORS; PARABOLIC BODIES; DISTORTION; OPTICAL PROPERTIES

Identifiers: LAMELLAR GRATING INTERFEROMETERS; CZERNY-TURNER COLLIMATING SYSTEMS; EVALUATION

RANK, D.H., YODER, P.R., and VRABEL, J.
"SENSITIVITY OF A RAPID TEST FOR HIGH SPEED PARABOIC MIRRORS"
J. Opt. Soc. Am., 39, 36 (1949)

No abstract provided.

RUBEN, P.L.
"REFRACTIVE NULL CORRECTORS FOR ASPHERIC SURFACES"
Appl. Opt., 15, 3080 (1976)

A null corrector is a lens designed to have spherical aberration such that the emerging wavefront matches the desired aspheric surface somewhere along the optical axis. Null-corrector design is discussed and 8 examples of testing are shown (6 Refs.).

Descriptors: OPTICAL DESIGN TECHNIQUES; ASPHERICAL LENSES; ABERRATIONS; OPTICAL TESTING

Identifiers: ASPHERIC SURFACES; SPHERICAL ABERRATION; DESIGN; TESTING; REFRACTIVE NULL CORRECTOR

SAXENA, A.K.
"QUANTITATIVE TEST FOR CONCAVE ASPHERIC SURFACES USING A BABINET COMPENSATOR"
Appl. Opt., 18, 2897 (1979)

A quantitative test for the evaluation of surface figures of concave aspheric surfaces using a Babinet compensator is reported. A theoretical estimate of the sensitivity is 0.002 lambda for a minimum detectable phase change of 2 pi x 10^{-3} rad over a segment length of 1.0 cm

SIMPSON
"TESTING CONVEX ASPHERIC LENS SURFACES WITH A MODIFIED HINDLE ARRANGEMENT"
Opt. Shop Notebook, IX, 45 (1975)

The well known principle of the Hindle sphere test for convex hyperboloids is extended to allow the use of a much smaller test sphere, and the central obscuration present in the classical setup is eliminated. The improvements are obtained by utilizing a half-silvered Handle surface only a few inches from the aspheric and then testing through it. This spherical surface is made on optical quality glass with no central perforation. The Hindle substrate thus becomes an active element is the test and so several design approaches are suggested to compensate for the spherical aberration introduced when the test beam passes through it. Each of the plate on the soft lens substrate were among the more compelling objections. Another obvious approach would have been to make a large null lens. But here it would have to produce a converging aspheric wavefront so that it would either involve quite a number of large elements or some of the element sufaces would themselves have to be aspherized. As with all null lens work, certain doubts would persist concerning the viability of the test setup until the first finished parts were put into service.

The need for shop testing and final Quality Assurance and Control of these parabolic surfaces has spawned a new improvement based on the Hindle principle. The present idea reduces the number of test elements to three lenses with mild spherical surfaces of no particular difficulty. In most of the cases to be described, the entire test setup can be independently certified before the production run begins. In another case, only one test element need be "trusted" and even then is measureable parameters leave little doubt as to the reliability of the whole test setup. It turns out that these new ideas are most applicable when the desired aspheric is very fast, just the condition where testing is most difficult by other more conventional means.

SIROHI, R.S.
"SYNTHETIC HOLOGRAPHY FOR OPTICAL TESTING"
J. Opt., 4, 79 (1975)

Computer generated holograms (CGHS) have been used for the testing of aspherical surfaces. The CGH acts as a reference element in an interferometric configuration. The CGHS may be generated with by coding both amplitude and phase or by coding only the phase of the wavefront. It may be safely assumed that the wavefronts encountered during testing are of uniform amplitude and hence the methods using only phase coding for the generation of the hologram are of more relevance to testing. The procedure by Birch et al. (1972) for generating CGH is modified. This modified procedure along with the concept of aberration balancing extends the capability of the CGH: Even steep aspherics can be tested. The CGHS have been generated for the wavefront from a plano-convex lens both for its axial and off-axial positions (20 Refs.).

Descriptors: HOLOGRAPHY; OPTICAL TESTING; ABERRATIONS
Identifiers: ASPHERICAL SURFACES; INTERFEROMETRIC CONFIGURATION; WAVEFRONTS; PHASE CODING; ABERRATION BALANCING; COMPUTER GENERATED HOLOGRAMS; PLANO CONVEX LENS; OPTICAL TESTING

TAKAHASHI, T., KONNO, K., and KAWAI, M.
"SOME IMPROVEMENTS IN COMPUTER HOLOGRAM FOR TESTING ASPHERIC SURFACE"
Jap. J. Appl. Phys., 14, 247 (1975)

In order to produce an accurate aspheric surface, it is necessary to know the exact shape of that surface in the process of polishing. For this purpose, an interferometer has been developed using computer generated holograms. Experiments were made on that apparatus with three kinds of computer generated holograms. They are 1) interferogram, 2) Lohmann type hologram and 3) included bar type hologram. A software has been developed to draw interferogram, but generally computer time to draw it was larger than that to obtain a Lohmann type hologram. The deterioration of the interference pattern when using a Lohmann type hologram could be remedied by using a proposed 'inclined bar' type hologram to some extent. Therefore, the included bar type hologram is more practical for the purpose of testing an aspheric surface (4 Refs.).

Descriptors: HOLOGRAPHIC INTERFEROMETRY; OPTICAL TESTING; SURFACE MEASUREMENT; PHYSICS APPLICATIONS OF COMPUTERS; HOLOGRAPHIC INSTRUMENTS; ASPHERICAL LENSES

Identifiers: COMPUTER HOLOGRAM; TESTING; ASPHEERIC SURFACE; POLISHING; INTERFEROMETER; INTERFEROGRAM; LOHMANN TYPE HOLOGRAM; INCLINED BAR TYPE HOLOGRAM; SOFTWARE; INTERFERENCE PATTERN

TAKAHASHI, T., KONNO, K., KAWAI, M., and ISSHIKI, M.
"COMPUTER GENERATED HOLOGRAMS FOR TESTING ASPHERIC LENSES"
Appl. Opt., 15, 546 (1976)

A computer generated hologram is introduced and names the inclined bar hologram. Analysis is given of the binary hologram and a method for drawing the inclined bar hologram is described with an evaluation of the errors. Interferometric measurements of the fabrication error of a lens surface are described to assess the performance of the inclined bar hologram (5 Refs.).

Descriptors: HOLOGRAPHY; OPTICAL TESTING; ASPHERICAL LENSES

Identifiers: COMPUTER GENERATED HOLOGRAM; INCLINED BAR HOLOGRAM; BINARY HOLOGRAM; FABRICATION ERROR; ASPHERIC LENS TESTING

WILLIAMS, T.L.
"QUALITY ASSURANCE OF ASPHERIC SURFACES"
Soc. Photo-Optical Inst. Engr(s), Bellingham, WA (1977)

A problem associated with manufacturing aspherics is that of testing the finished components. Some of the assessment techniques which can be used, particularly for testing highly aspheric surfaces, are reviewed and a new instrument recently developed for this purpose is described in some detail. The different techiques dealt with are interferometric, holographics, pupil scan (ray tracing) and mechanical (16 Refs.).

Descriptors: OPTICAL TESTING; HOLOGRAPHY; LIGHT INTERFEROMETRY; ASPHERICAL LENSES

Identifiers: ASPHERIC SURFACES; TESTING; INTERFEROMETRIC;

HOLOGRAPHIC; PUPIL SCAN; RAY TRACKING;
MECHANICAL; QUALITY ASSURANCE

WILLIAMS, T.L.
"A SCANNING GAUCE FOR MEASURING THE FORM OF SPHERICAL AND ASPHERICAL SURFACES"
Opt. Acta., 25, 1155 (1978)

A new instrument is described for measuring the form (or figure) of spherical and aspherical surfaces. The technique is basically mechanical and utilizes two high-precision air bearings. The test surface is mounted on one of these bearings, while the other carries an arm with a sensitive mearuing probe which scans across the surface. Both contacting and non-contacting probes may be used. The instrument has been developed mainly to satisfy the growing need to test highly aspheric surfaces. Particularly in connection with the manufacture of lenses and mirrors for thermal imaging applications. However, the instrument has many advantages over exisitng techniques when applied to the testing of normal spherical surfaces. In particular, it requires no test plates, it can be used to test steeply curved surfaces which are either concave or convex in form (The latter i is always a problem with most other methods), a finally it can be used to test surfaces in either their polished or grey states (8 Refs.).

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; SURFACE TOPOGRAPHY MEASUREMENT; LENSES; MIRRORS

Identifiers: SCANNING GAUGE; MEASURING; ASPHERICAL SURFACES; FORM; LENSES; MIRRORS; THERMAL IMAGING APPLICATIONS; SPHERICAL SURFACES; HIGH PRECISION AIR BEARINGS

WINER, I.M.
"ITNERFEROMETRIC DETERMINATION OF CONIC SECTIONS"
Opt. Shop Notebook, IX, 74 (1975)

No abstract provided.

WYANT, J.C.
"TESTING ASPHERICS USING TWO-WAVELENGTH HOLOGRAPHY"

It is shown that both single exposure and double exposure two-wavelength holography provides a good method of using visible light to obtain an interferogram identical to what would be obtained if a long nonvisible wavelength were used. Both techniques provide for the real-time adjustment of defocus and tilt in the final interferogram. When both hologram exposures are mode simultaneously, the sensitivity to air turbulence is essentially the same as if the long nonvisible wavelength were used. Results are shown for testing both lenses and mirrors at equivalent wavelengths at 6.45 micromenters, 9.47 micrometers, 14.20 micrometers, 20.22 micrometers and 28.50 micrometers obtained by using an argon laser for the visible light source.

WYANT, J.C. and BENNETT
"USING COMPUTER GENERATED HOLOGRAMS TO TEST ASPHERIC WAVEFRONTS"

The use of computer generated holograms for the testing of aspheric wavefronts is described. An analysis of the errors produced by emulsion movement, incorrect hologram size and position, and distortion in hologram plotter and photoreduction lens is given, and it is shown that all the errors are proportional to the slope of the aspheric wavefront. Experimental results verifying the error analysis are shown for testing rotationally nonsymmetric wavefronts having slopes as large as 125 waves per radius and departures are large as sixty-five waves.

WYANT, J.C. and O'NEILL, P.K.
"COMPUTER GENERATED HOLOGRAM NULL LENS TEST OF ASPHERIC WAVEFRONTS"
Appl. Opt., 13, 2762 (1974)

To test an aspheric optical element, a second optical system (null lens or mirror) is often used to convert the aspheric wavefront into either a spherical or plane wavefront which is then compared interferometrically with a known wavefront. Accurate null optics for testing steep aspherics are expensive. Results for a test of the primary mirror of an eccentric cassegrain system are described which show that inexpensive null optics are possible when combined with a relatively simple computer generated holograms (12 Refs.).

Descriptors: OPTICAL TESTING; ASPHERIC LENSES; HOLOGRAPHY
Identifiers: COMPUTER GENERATED HOLOGRAM; NULL LENS TEST; ASPHERIC WAVEFRONTS; ECCENTRIC CASSEGRAIN SYSTEM; PRIMARY MIRROR

YOKOZEKI, S. and OHNISHI, K.
"SPHERICAL ABERRATON MEASUREMENT WITH SHEARNG INTERFERMETER USING FOURIER IMAGING AND MOIRE METHOD"
Appl. Opt. 14, 623 (1975)

In this shearing interferometer, a collimated monochrmatic beam illuminates a rating to produce good contrast interference fringes periodically at distance ND/SUP 2//Lamda from the grating. The fringes are of the same spacing (D) as the grating and constitute a fourier image of the grating. If a phase object is placed between the grating and its fourier image, the fourier image is distorted. A second grating (master grating) is superimposed on the distorted fourier image to produce a moire pattern. The informaton obtained is the partial derivative of the departure from the reference wavefront caused by the phase object. In an arrangement using a spherical reference wavefront (see Abst. A57178 of 1971) to measure the lateral spherical aberration of a camera lens with small F-number (1.7), it is shown that it is necessary to correct for distortion of the observed fringes. An arrangement usng a plane reference wavefront is described and this gives the lateral spherical aberration directly from the moire pattern. Theory is given for both arrangements (6 Refs.).

Descriptors: LIGHT INTERFEROMETRY; OPTICAL VARIABLES MEASUREMENT; ABERRATIONS; OPTICAL TESTING
Identifiers: COLLIMATED MONOCHROMATIC BEAM; FRINGE DISTORTION CORRECTON; SPHERICAL ABERRATON MEASUREMENT; SHEARING INTERFEROMETER; FOURIER IMAGING; MOIRE METHOD; PHASE OBJECT; CAMERA LENS

ZIMMERMAN, J. and REYNOLDS, B.R.
"ASPHERIC ELEMENTS FOR PERFORMANCE IMPROVEMENT AND COST REDUCTION IN INFRARED SYSTEMS"
Proceedings of the Society of Photo-Optical Instrumentation Engineers, Volume 131. Practical Infrared Optics 50-6 (1978).

Improved image quality, reduced shading and high transmission can be obtained. While at the same time the system t is reduced. The manufacturing and test technologies which allow for cost effective use of aspherics are described. An advanced small FLIR which uses aspherics is cited as an example of the concepts presented (5 Refs.).

Descriptors: INFRARED IMAGING; APHERICAL LENSES; OPTICAL TESTING

Identifiers: PERFORMANCE IMPROVEMNT; COST REDUCTION; IMAGE QUALITY; SHADING; TRANSMISSION; TEST TECHNOLOGIES; ASPHERICS; MANUFACTURING TECHNOLOGIES; FORWARD LOOKING IR SYSTEMS

ZUBAKOV, V.G.
"MEASURING THE DECENTERING OF ASPHERIC SURFACES"
<u>Sov. J. Opt. Technol., 39</u>, 224 (1972)

An interferometric method is suggested for measuring the decentering of an aspherical surface in terms of the eccentricity of one or several zones of contact between the tested component and a test glass.

Descriptors: OPTICAL TESTING; ASPHERICAL LENSES; LIGHT INTERFEROMETRY

Identifiers: DECENTERING; ASPHERICAL SURFACES; INTERFEROMETRIC METHOD

AEMMER, A.H. and TIZIANI, H.J.
"DISCUSSION OF A HOLOGRAPHIC METHOD TO MEASURE THE OPTICAL TRANSFER FUNCTION"
Optik, 36, 443 (1972)

The application of the holographic method to measure the autocorrelation functon, suggested by Francon et al (1966) is studied. The optical transfer function of the Plankonvex lens "Sira" (F=50 MM) was measured. The influence of the mechanical stability and the nonlinearity of the photographic emulsion on the results is investigated. Mechanical errors are simulated and the corresponding experimental and theoretical results are compared (7 Refs.).

Descriptors: HOLOGRAPHY; LENSES; TRANSFER FUNCTONS; OPTICAL TESTING
Identifiers: OPTICAL TRANSFER FUNCTION; AUTOCORRELATON FUNCTION; PLANKONVEX LENS; HOLOGRAPHIC MEASUREMENT METHOD

AMBERG, K.H.
"MTF LENS TESTER FOR PRODUCTION CONTROL AND LABORATORY MEASUREMENTS"
Soc. Photo-Optical Instrumentation Engrs. (1974)

The K VL lens tester has been developed especialy for production quality control; yet, it is also employed for laboratory tests (1 Refs).

Descriptors: LENSES; OPTICAL INSTRUMENT TESTING; OPTICAL IMAGES; TRANSFER FUNCTIONS; PRODUCTION CONTROL
Identifiers: LENS TESTER; PRODUCTION CONTROL; LABORATORY MEASUREMENTS; PRODUCTION QUALITY CONTROL

ARNULF, A.
"METHODS AND APPARATUS FOR MEASURNG PERFORMANCE AND QUALITY OF OPTICAL INSTRUMENTS"
Optical Image Evaluation, Gardner, I. (1954)

No abstract provided.

ASAEDA, T., FUJIBAYASHI, K., and MINAMI, S.
"INFLUENCE OF POLAR INTENSITY DISTRIBUTION OF LIGHT SOURCE ON MTF MEASUREMENT"
Soc. Photo-Optical Instrumentation Eng. (1977)

In many methods to measure the modulation transfer function (MTF) of an optical system. A pinhole or a slit is used as a test target. In such methods, the light flux that is diverging from a test target must illuminate the full aperture of the test lens evenly. In practice, however, it is rare to satisfy this condition especially for a measurement of an optical system of high numerical aperture. The insufficient illumination causes some amount of error on the measured MTF values. The authors describe a method for estimating the error of MTF values that are caused by the difference of illumination condition (2 Refs.).

Descriptors: OPTICAL TESTING; LENSES; OPTICAL TRANSFER FUNCTION; LIGHT SOURCES
Identifiers: POLAR INTENSITY DISTRIBUTION; LIGHT SOURCE; MTF MEASUREMENT; OPTICAL SYSTEM; FULL APERTURE; TEST LENS; HIGH NUMERICAL APERTURE

BAKER, J.G.
"IMAGE STRUCTURE AND TEST DATA"
Optical Image Evaluaton, Gardner, I. (1954)
No abstract provided.

BIGELMAIER, A., SCHAEFER, K.D., and WASMUND, H.
"AN INSTRUMENT FOR MEASURING TRANSFER FUNCTIONS AND LINE SPREAD FUNCTIONS OF CAMERA LENSES"
A testing instrument for camera lenses is described which automatically measures transfer functions and line spread functions provided the focusing plane is maintained. The frequency covers a continuous range of 0 lines/mm to 150 lines/mm. The gauging to 1 with 0 lines/mm of the transfer function is automatic under all f stop, color, and defocusing conditions. The misalignment caused by instrumentation and the measuring principle is compensated by a function potentiometer. The instrument described allows focusing to infinity by collimators and focusing up to 6 m without collimators. Evaluated and measured curves are compared.

BROCK, G.C., BARAKAT, R., KITROSSER, E.B., DUSSAULT, R.L., and ATTAYA, W.L.
"STUDY OF IMAGE-EVALUATON TECHNIQUES"
Itek Interim Engrg. Rpt., 7 (1964)
The goal of this image evaluation study is the development of a mathematical model for calculating the performance of reconnaissance systems. An essential foundation for this effort is the ablitity to measure or calculate the physical characteristics of lenses, emulsions, and other components of these systems with the requisite accuracy. Interim Engineering Report (AD-600 950) described progress made with the Itek Image Analyzer Unit (Model 11) used for measuring the transfer function of lenses. This report presents calculations of the line spread function and edge spread function as derived from the transfer function: the axial image is considered in the presence of various degrees of third-order spherical aberration and defocusng. A simplified graphical method for derivng single-bar response from the edge spread function is described. Experimental work is recorded on the measurement of lens-film transfer functions, in which both sinusoidal targets and edges are used, with 50-243 emulson. The mathematical basis for the transform program currently used with Itek's CDC-924 computer when derivng transfer functions from edge traces is coherent light method for measuring emulsion transfer functions is presented.
Descriptors: (AERIAL PHOTOGRAPHY, SIMULATION), (AERIAL RECONNAISSANCE, MATHEMATICAL MODELS), (PHOTOGRAPHIC TECHNIQUES, ANALYSIS), PHOTOGRAPHIC IMAGES, PHOTOGRAPHIC LENSES, PHOTOGRAPHIC EMULSIONS, PHOTOGRAPHIC FILM, OPTICS, FUNCTIONS, GRAPHICS

COLEMAN, H.S.
"IMAGE QUALITY AS USED BY THE GOVERNMENT INSPECTOR OF VISUAL TELESCOPIC INSTRUMENTS"
Optical Image Evaluation, Gardner, I. (1954)
No abstract provided.

CONSITT, F.J.P.
"SOME MTF ROUTINES FOR THE ASSESSMENT OF PHOTOGRAPHIC LENSES"
Soc. Photo-Optical Instrumentation Eng. (1974)
Sets of through focus MTF response curves on axis. At half field, three-quarter field, and full field reveal the characteristics of the radial and tangential focal surfaces from which a focus setting may be chosen to give the best overall response for the specific requirements of the lens. A standard format of MTF curves through field at this focus setting is then obtained for a quick assessment of a lens or for a comparison of several lenses in a production run, an abbreviated test routine with the object and image slits at 45 degrees orientation has proved useful. Examples of the application of these routines are given (1 Refs.).
Descriptors: PHOTOGRAPHIC LENSES; OPTICAL INSTRUMENT TESTING; OPTICAL IMAGES; TRANSFER FUNCTIONS
Identifiers: MODULATION TRANSFER FUNCTION; RADIAL FOCAL SURFACES; PHOTOGRAPHIC LENSES; TANGENTIAL FOCAL SURFACES; FOCUS SETTING; TEST ROUTINE

COX, A.
"IMAGE EVALUATION BY EDGE GRADIENTS"
Optical Image Evaluation, Gardner, I. (1954)
No abstract provided.

DAVYDKIN, I.M. and LESINA, T.M.
"REPRESENTATION OF MEASURED LENS MODULATION-TRANSFER FUNCTIONS BY THE KEY COMPONENT METHOD"
Sov. J. Opt. Technol., 39, 329 (1972)
Descriptors: TRANSFER FUNCTIONS; PHOTOGRAPHIC LENSES; OPTICAL TESTING
Identifiers: MODULATION TRANSFER FUNCTION; KEY COMPONENT METHOD; 90 MTF'S; 30 PHOTOGRAPHIC LENSES

DUTTON, D.
"PROCEDURE FOR OVER-ALL LENS EVALUATION USING OTF DATA"
Appl. Opt., 11, 1091 (1972)
A method is described for making use of large amounts of photoelectric test data, recorded in the form of OTF curves and filed in computer-accessible form, to evaluate image quality over the field in an arbitrary image plane or to locate an optimum image plane by computer processing of the recorded data. Merit parameters such as the OTF, the predicted photographic resolution, the Strehl criterion and others, are obtained as over-the-field averages, with arbitrary weighting of information from different parts of the field, and also may be reported from individual field points in various

ways. The method has been tested on a wide-angle aerial photographic objective, and example results for this lens are given. Assessment of the possible utility of such a procedure is based on discussion of the practical feasibility of acquiring large amounts of test data automated instruments, on the computer requirements and processor time needed, and examples of the variety of evaluation tasks that may be performed, with relative ease once the imagery has been mapped throughout the image space. It is concluded that the method does offer possibilities for practical use and may be a desirable way to utilize directly OTF-type test information, in mass, to faclitate decision making in respect to design, fabrication quality, or individual performance of an actual prototype of production lens (7 Refs.).

Descriptors: LENSES

Identifiers: LENS EVALUATION; IMAGE QUALITY; COMPUTER PROCESSING; PREDICTED PHOTOGRAPHIC RESOLUTION; STREHL CRITERION; OPTICAL TRANSFER FUNCTION

DUTTON, D.
"IMAGE ASSESSMENT SPECIFICATION"
Soc. Photo-Optical Instrumentation Eng. (1974)

The following topics were dealt with optical transfer function measurement, standards and application to lens design; interferometric measurement methods; instrments for testing image quality of optical systems including satellite systems, electro-optical devices and infrared imaging systems. 43 papers were presented, of which all are published in full in the present proceedings.

Descriptors: OPTICAL SYSTEMS; OPTICAL IMAGES; TRANSFER FUNCTIONS; LENSES; OPTICAL INSTRUMENT TESTING; MEASUREMENT STANDARDS; LIGHT INERFEROMETRY; GEOPHYSICAL EQUIPMENT; ELECTRO-OPTICAL DEVICES; INFRARED IMAGING

Identifiers: ELCTROOPTICAL DEVICES; OPTICAL TRANSFER FUNCTION; STANDARDS; LENS DESIGN; INTERFEROMETRIC MEASUREMENT METHODS; TESTING; IMAGE QUALITY; OPTICAL SYSTEMS; SATELLITE SYSTEMS; INFRARED IMAGING SYSTEMS

DUTTON, D.
"USA STANDARDS ON OTF"
Soc. Photo-Optical Instrumentation Eng. (1976)

Describes the present form and status of a draft proposal for a docmentary standard on the optical transfer function. The aims of the proposed document are to provide for imaging devices in general and particularly for lenses, a consistent set of definitions and nomenclature for the spread. Transfer and pupil functions, the relations among them, and the principles of measurement, using several alternative measuring techniques as detailed examples, and advise on some common sources or error and their minimization to enumerate conditions that need to be specified in connection with OTF testing; and to provide a basic format and nomenclature for specifying the extent of such tests and for reporting the results. It is expected that subsequent standards, using this document as foundation, can concisely specify particular test limits or measuring methods, as appropriate to particular devices or applications (1 Ref.).

Descriptors: OPTICAL TRANSFER FUNCTION; LENSES;

MEASUREMENT STANDARDS; PHOTOGRAPHIC LENSES; OPTICAL TESTING; NOMENCALTURE AND SYMBOLS; OPTICAL INSTRUMENT TESTING

Identifiers: OFT; IMAGING DEVICES; LENSES; SET OF DEFINITIONS; NOMENCLATURE; PUPIL FUNCTIONS; TEST LIMITS; MEASURING METHODS; USA STANDARDS; SPREAD FUNCTON; TRANSFER FUNCTION

EICHLER, W.
"MODERN SERIAL TESTING OF PHOTOGRAPHIC LENS SYSTEMS"
Jena Rev., 23, 142 (1978)

It is the task of serial testing to detect in the course of the production process those lens systems whose performance lies below a certain limit, and to determine the cause, if necessary. In serial testing, resolving power limits are laid down for the photo centre and for at least two extra-axial image heights which must not fall below (8 Refs.).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL IMAGES; OPTICAL RESOLVING POWER; OPTICAL INSTRUMENT TESTING

IDENTIFIERS: SERIAL TESTING, PHOTOGRAPHIC LENS SYSTEMS; PRODUCTION PROCESS; RESOLVING POWER LIMITS; EXTRA AXIAL IMAGE HEIGHTS

EVTEEVA, N.P., LESINA, T.M., KLIMANOVA, N.P., and STRYGINA, A.N.
"THE USE OF MODULATION TRANSFER FUNCTIONS FOR TESTING COMMERCIALLY MANUFACTURED PHOTOGRAPHIC OBJECTIVE LENSES"
Sov. J. Opt. Technol., 43, 254 (1976)

The Eigenvector method is applied to an analysis of experimental measurements on a group of objectives and a relationship is derived which enables the lens MTFS to be used in place of the more subjective photographic resolution power in evaluating the performance of the lenses, thus enabling testing of objectives to be automated. PR and MTC values for six sample lenses are tabulated to illustrate the principle (9 Refs).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTING; TRANSFER FUNCTIONS;

Identifiers: MODULATION TRANSFER FUNCTONS; TESTING COMMERCIALLY MANUFACTURED PHOTOGRAPHIC OBJECTIVE LENSES; EIGENVECTOR METHOD; AUTOMATION

GLIATTI, E.L.
"IMAGE EVALUATION METHODS"
Soc. Phot-Optical Instrmentation Eng. (1978)

The Air Force and most of industry rely heavily on measurements of system resolution for specifying and evaluating performance. System resolution, despite its limitations, generally has been easy to measure, readily accepted. Proven effective in serially grading lenses, systems, etc., and not known to cause significant errors. The methods usually used by the Air Force to measure resolution are Tribar Target (RP) reading: visual edge matching (VEM); maximum magnification factor (MMF); and modulation transfer function (MTF). All four methods are used when conditions warrant, and where the required equipment is available. The air staff has established project "Sentinel Sigma" to improve appropriate emphasis to this effort. Within this program, all image evaluation methods are being evaluated at the Air Force Sensor Evaluation Center (AFSEC) to determine their adequacy of measuring image quality (18 Refs.).

Descriptors: IMAGE SENSORS; MILITARY SYSTEMS; CARTOGRAPHY; OPTICAL VARIABLES MEASUREMENT; OPTICAL RESOLVING POWER; OPTICAL TRANSFER FUNCTION

Identifiers: RESOLUTION; SENTINEL SIGMA; IMAGE EVALUATION; IMAGE QUALITY; IMAGE EVALUATION MILITARY

GRIMES, D.N.
"OPTICAL AUTOCORRELATOR WITH SPECIAL APPLICATION TO MTF MEASUREMENT"
Appl. Opt., 11, 914 (1972)

An optical autocorrelator is described which is based on a modified Sagnac two-mirror interferometer that operates in the zero-fringe mode. The real-time radiant flux output is the square of the autocorrelation of the aperture function. In a particular application, when the aperture function is the pupil function of a lens under test, the autocorrelator output is the MTF of the lens. The system is not limited in focal length; aperture size is limited only by the sizes of the beam splitters and mirrors. Experimental results are given with comparison data for both infinite-conjugate MTF and the autocorrelation of an annular aperture. Methods of adapting the system for measurement of the phase of the transfer function and for finite conjugate testing are also described.

GROVER, C.
"SIMPLIFIED PROCEDURES FOR EVALUATING THE IMAGE QUALITY OF OBJECTIVE LENSES FOR NIGHT VISION DEVICES"
Nat. Inst. Law Enforcement and Criminal Justice (1974)

Users of night vision devices (NVD) in law enforcement work may at some time desire to modify the capability of their NVD by employing a photographic lens. This report describes two methods of testing the suitability of such photographic lenses for use with particular NVD's. These methods described are the low contrast resolution test (LCRT) and the variable contrast resolution Test (VCRT). Both evaluate a photographic lens limiting resolution at a particular contrast level or as function of contrast. Although the VCRT is more complex and provides better overall evaluation, both procedures have correlated well with lens ranking data obtained by complicated modulation transfer function methods and are recommended as simple criterion tests for lens suitability. Illustrative graphs and photographs are provided.

Descriptors: OPTICAL TESTING; INFRARED IMAGING; PHOTOGRAPHIC LENSES

Identifiers: IMAGE QUALITY; OBJECTIVE LENSES; NIGHT VISION DEVICES; PHOTOGRAPHIC LENS; OPTICAL TESTING; LENS SUITABILITY

HEIDINGER, D., HERTEL, J. and ULBRICH, G.
"SIMPLE METHOD OF DESCRIBING THE PHOTOGRAPHIC IMAGE QUALITY"
Opt. Acta, 24, 617 (1977)

If the conclusions which Kondo et al (1975) obtained by testing a large number of photograhic lenses (35 MM cameras) are combined with the quality number suggested by Heynacher (1963) a very simple method of describing the photographic image quality is achieved. This method, its origin, and some results are discussed (7 Refs.).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TESTING; OPTICAL TRANSFER FUNCTION

Identifiers: PHOTOGRAPHIC IMAGE QUALITY; PHOTOGRAPHIC LENSES; 35 MM CAMERAS; QUALITY NUMBER; MTF

HERRIOTT, D.R. and BRUNING, J.H.
"MODULATION TRANSFER FUNCTION BY MEASUREMENT OF THE PUPIL FUNCTION"
Soc. Photo-Optical Instrumentation Eng. (1974)

A system has been constructed in which an interferometer fringe pattern of the aperture of the lens under test is measured by an array of photodiodes while the phase of the interference is changed by a piezoelectrically driven mirror in the interferometer. A phase shift is introduced into the interferometer and the measurement is repeated. A series of these cycles generates a Fourier series description of the approximately sinusoidal intensity variation that would be expected at each diode. The relative phase of this sine wave is the phase of the interference pattern at this point with respect to the phase at other points in the aperture.

Descriptors: TRANSFER FUNCTIONS; OPTICAL IMAGES; OPTICAL INSTRUMENT TESTING; LENSES; LIGHT INTERFEROMETRY

Identifiers: LENS TESTING; MODULATION TRANSFER FUNCTION PUPIL FUNCTION; INTERFEROMETER FRINGE PATTERN; APERTURE; LENS PHASE SHIFT; FOURIER SERIES

HOPKINS, H.H.
"INTERFEROMETRIC METHODS FOR THE STUDY OF DIFFRACTON IMAGES"
Opt. Acta, 2}, 23 (1955)

No abstract provided.

HOPKINS, R.E., KERR, H., LAUROESCH, T., and CARPENTER, V.
"MEASUREMENTS OF ENERGY DISTRIBUTION IN OPTICAL IMAGES"
Optical Image Evaluation, Gardner, I. (1954)

No abstract provided.

HOPKINS, R.E. and DUTTON, D.
"LENS TESTING OR IMAGE EVALUATION"
Photogramm. Eng., 39, 275 (1973)

Lenses need to be tested in ways similar to the methods used in lens design so that the designers can obtain accurate information. The article discussed the optical transfer function and the need for a single figure at merit (2 Refs.).

Descriptors: LENSES; OPTICAL TESTING; OPTICAL IMAGES

Identifiers: LENS TESTING; IMAGE EVALUATION; OPTICAL TRANSFER FUNCTION; FIGURE OF MERIT

HOPKINS, H.H.
"THE DEVELOPMENT OF IMAGE EVALUATION METHODS"
Soc. Photo-Optical Instrumentation Eng. (1974)

A brief history is presented of the treatment of aberrations in image formation by mirrors and lenses. The development of wave theory and diffraction theory to improve practical lens design is described. The origins of the concept of an optical transfer function or modulation transfer function and its importance in evaluating image quality are discussed. Some basic aspects of geometrical and diffraction optics relevant to the problem of image evaluation are summarized.

Descriptors: OPTICAL IMAGES; ABERRATIONS; GEOMETRICAL OPTICS; TRANSFER FUNCTIONS; REVIEWS

Identifiers: GEOMETRICAL OPTICS; IMAGE EVALUATION METHODS; ABERRATIONS; IMAGE FORMATION; MIRRORS; LENSES; WAVE THEORY; DIFFRACTION THEORY; LENS DESIGN; OPTICAL TRANSFER FUNCTION; MODULATION TRANSFER FUNCTION; IMAGE QUALITY; DIFFRACTION OPTICS

HOWLETT, L.E.
"BASES FOR TESTING PHOTOGRAPHIC OBJECTIVES"
Optical Image Evaluation, Gardner, I. (1954)

No abstract provided.

HYZER, W.G.
"LENS TESTING"
Res. Dev., 14, 77 (1973)

Definition, resolving power, sharpness, acutance, granularity, spread function and MTF value are key factors when evaluating an optical system's image-forming capability. The author describes practical information on how they can help insure optimum lens performance.

Descriptors: LENSES; OPTICAL TESTING

Identifiers: LENS TESTING; RESOLVING POWER; SHARPNESS; ACUTANCE; GRANULARITY; SPREAD FUNCTION; MTF VALUE; OPTIMUM LENS PERFORMANCE; DEFINITION

INGELSTAM, E. and LINDBERG, P. J.
"A COMBINED TEST PROCEDURE FOR CAMERA LENSES, AND PHOTO-ELECTRIC EXAMINATION OF INTENSITY DISTRIBUTION IN LINE IMAGES"
Optical Image Evaluation, Gardner, I. (1954)

No abstract provided.

ITEK CORP.
"STUDY OF IMAGE-EVALUATION TECHNIQUES"
Itek Corp., Lexington, Mass., Rept. No. 12 (1965)

The primary goal of this program is the development of a valid computational means for determining object to image relationships in photo-optical reconnaissance systems. Our attention is currently restricted to the lens- film combination. The investigation has been primarily based on linear transfer function, or spatial frequency, analysis. In the area of lens response. the basic linearity of the optical system makes this analysis valid, if not completely sufficient (e.g., veiling glare is not accounted for by the lens transfer function). In the areas of film response, nonlinear analysis must be resorted to in order to account for the fundamental nonlinearity attested to by the D-log E curve as well as for the much less well understood effects of finite chemical diffusion rate properties commonly called adjacency effects. Because of the many problems in film response analysis, the major emphasis in the program is on emulsion studies. Our research activity is generally separable into lens, film lens-film system, and computer programming categories. In essence, our experimental and theoretical studies in the lens, film, and lens-film system areas are to provide the conceptual and practical foundations for a computer program that will make possible the clacualtion of object to image relationships in general lens-film systems.

Descriptors: (AERIAL PHOTOGRAPHY; PHOTOINTERPRETATION); AERIAL RECONNAISSANCE; THEORY; OPTICS; PHOTOGRAPHIC IMAGES; MATHEMATICAL MODELS; CAMERA LENSES; PHOTOGRAPHICEMULSIONS; RESOLUTION; PROGRAMMING (COMPUTERS); STATISTICAL ANALYSIS

JOHANSSON. S. and PREDKO, K.
"A METHOD FOR MTF EVALUATION FROM THE IMAGE OF A VARIABLE SLIT"
Opt. Acta, 23 549 (1976)

A method is proposed for the determination of the modulation transfer function (MTF) of optical systems with symmetrical spread function. In the image of a variable slit the central irradiance is measured and from that the MTF is calculated by means of a suggested formula on a desk calculator. A device, characterized by its simplicity, for MTF measurements of lenses is described as a test lense from sira and known MTF is evaluated (18 Refs.).

Descriptors: OPTICAL TESTING; OPTICAL INFORMATION PROCESSING; LENSES; TRANSFER FUNCTIONS

Identifiers: MTF EVALUATION; VARIABLE SLIT; OPTICAL SYSTEMS; SYMMETRICAL SPREAD FUNCTIONS; CENTRAL IRRADIANCE; TEST LENS; MEASUREMENT DEVICE

KONDO, H., WATANABE, T., and YAMAOKA, H.
"CRITERIA FOR THE EVALUATION OF PHOTOGRAPHIC LENSES"
Opt. Acta, 22, 353 (1975)

Simplified test condition for the evaluation of lenses based on MTF measurements are described, and criteria for interchangeable lenses for 35MM cameras are proposed. Measurements are made for white light, at the infinite conjugate plane, on axis and at 0.7 field (15 MM off axis) positions, at full aperture and F/5.6. The focus is adjusted at each aperture so as to give the best MTF response at 30 lines/MM on axis. The MTF responses at 15 and 30 lines/MM are examined for the evaluation of the lenses. Simple criteria based on the experimental data for about 100 different types of interchangeable lenses are proposed.

Descriptors: OPTICAL TESTING; PHOTOGRAPHIC LENSES; TRANSFER FUNCTIONS

Identifiers: EVALUATION CRITERIA; MTF MEASUREMENTS; PHOTOGRAPHIC LENSES; TEST CONDITIONS; INTERCHANGABLE LENSES; 35 MM CAMERAS; WHITE LIGHT; INFINITE CONJUGATE PLANE

KONDO, H. and YAMAOKA, H.
"NEW CRITERIA FOR THE EVALUATION OF INTERCHANGEABLE LENSES FOR 135 CAMERAS"
Opt. Eng., 16, 601 (1977)

MTF-based simplified test conditions and proposed criteria for the evaluation of the image quality of fixed focal length lenses and zoom lenses for 35MM cameras are described. Measurements are made for white light. In the infinite conjugate plane, on-axis and at two 0.7 field (155 MM off-axis) positions, at full aperture and F/8. The focus is set at full aperture for best MTF response at 30 MM/Sup -1/ on-axis. The lenses are evaluated by examining the MTF responses at 10 MM/Sup -1/ and 30 MM/Sup -1/. Previously proposed conditions and criteria for fixed focal length lenses are also described for reference (1 Ref.).

Descriptors: PHOTOGRAPHIC LENSES; OPTICAL TRANSFER FUNCTION; OPTICAL TESTING

Identifiers: INTERCHANGEABLE LENSES; IMAGE QUALITY: FIXED FOCAL LENGTH LENSES; ZOOM LENSES: 35 MM CAMERAS; WHITE LIGHT; MTF RESPONSE; MTF BASED SIMPLIFIED TEST CONDITIONS

KUTTNER, P.
"REMARKS ON THE ACCURACY OF SPECTRAL RESPONSE MATCHING FOR MTF MEASUREMENTS"
Soc. Photo-Optical Instrumentation Eng. (1977)

Some parameters of greater or lesser importance for matching spectral response are discussed for specific lens types. The influence of the deviation of light-source color temperature and deviation of the detector's spectral response are shown for spectral energy distributions frequently used in practice. Although a general answer cannot be given. Certain trends and connections can be detected. The effect of different fluorescent phosphors on MTF measurements of stopped-down and high-aperture lenses is shown (8 Refs.).

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; LENSES

Identifiers: SPECTRAL RESPONSE MATCHING; MTF MEASUREMENTS; LENS TYPES; SPECTRAL ENERGY DISTRIBUTIONS; FLUORESCENT PHOSPHORS; LIGHT SOURCE COLOUR TEMPERATURE DEVIATION; STOPPED DOWN LENSES; HIGH APERTURE LENSES

LIDWELL, M.O.
"DEVELOPMENTS IN HIGH RESOLUTION THERMAL OPTICS"
Opt. Acta, 22, 317 (1975)

The present requirement for thermal imaging objectives at 8-13 mum giving di.fraction limited performance for apertures of up to 12 in. is explained and the choice of refracting germanium systems justified. The methods of manufacturing and testing such large components are then described. The MTF's as measured on a series of lenses, are discussed and shortfall in performance related to surface finish and quality of the germanium. The implications for thermal contrast at a target spatial frequency such as 5 line pairs/milliradian are considered. The practicality of thermal imaging has been established but it is shown that performance can be improved with higher quality germanium components (2 Refs.).

Descriptors: INFRARED IMAGING; OPTICAL DESIGN TECHNIQUES; OPTICAL RESOLVING POWER; LENSES; TRANSFER FUNCTIONS; OPTICAL TESTING

Identifiers: 8 to 13 MICRONS; IR; MTF; GE REFRACTING SYSTEMS; COMPONENT MANUFACTURE; COMPONENT TESTING; HIGH RESOLUTION THERMAL OPTICS; THERMAL IMAGING OBJECTIVES; DIFRACTION LIMITED PERFORMANCE; LENSES; SURFACE FINISH; THERMAL CONTRAST

MARCHANT, A.C., IRONSIDE, E.A., ATTRYDE, J.F., and WILLIAMS, T.L.
"THE REPRODUCIBILITY OF MTF MEASUREMENTS"
Opt. Acta, 22, 249 (1975)

MTF measurements have recently been carried out in a number of European laboratories on a typical wide-angle photographic lens. While showing similar differences than those occuring in earlier intercomparisons. The results still exhibited a greater variation than is desirable if the MTF is to be adopted universally in the specification assessment of lense performance, However, a detailed analysis of the results has indicated probable reasons for many of the differences, and when corrected in accordance with the results of this analysis the spread of MTF values has been greatly reduced, never exceeding +or- 0.07 and usually amounting to less than +or- 0.03. These residual differences are almost certainly smaller than anything which could be detected as a difference of picture quality (6 Refs.).

Descriptors: TRANSFER FUNCTIONS; PHOTOGRAPHIC LENSES; OPTICAL TESTING

Identifiers: WIDE ANGLE PHOTOGRAPHIC LENS; APREAD REDUCTION; REPRODUCIBILITY; MTF MEASUREMENT; PICTURE QUALITY

MARCHANT, A.C.
"MTF-BASED CRITERIAL FOR AIR-CAMERA LENS SPECIFICATIONS"
Opt. Acta, 22, 347 (1975)

In order to exploit the MTF as a quality control technique in the production of photographic lenses, it is necessary to reduce to a minimum the number of measurements to be made and or/compared. A number of "simplified" MTF criterial have been suggested for this purpose, and some of those most relevant in the context of aerial photography are described. Whichever criterion is selected, it must clearly represent the imaging characteristics of a lens sufficiently well to ensure good picture quality when the lens is put into service. A brief account is given of current work which

aims to compare the various criteria from this stand-point (6 Refs.).
Descriptors: PHOTOGRAPHIC LENSES; TRANSFER FUNCTIONS; OPTICAL DESIGN TECHNIQUES; QUALILTY CONTROL; OPTICAL TESTING
Identifiers: MTF BASED CRITERIA; AIR CAMERA LENS SPEICIFCATION; QUALITY CONTROL TECHNIQUE; PHOTOGRAPHIC LENSES; AERIAL PHOTOGRAPHY; PICTURE QUALITY

MARCHANT, A.C.
"REPRODUCIBILITY OF POLYCHROMATIC MODULATION TRANSFER FUNCTION (MTF) MEASUREMENTS"
Soc. Photo-Optical Instrumentation Eng. (1976)

Summary form only given. The previously reported investigation (Opt. Acta., 22, p. 249 (1975)) of the reproducibility of monochromatic MTF measurements on a standard wide-angle lens is now being extended to the polychromatic case. The author reviews the basic test parameters which must be considered in such a case if accurate results are to be obtained, and discusses the first results of the new intercomparison exercise.

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; LENSES; MEASUREMENT STANDARDS
Identifiers: REPRODUCIBILITY; POLYCHROMATIC MTF MEASUREMENTS; STANDARD WIDE ANGLE LENS

MCCAMY, C.S.
"PRECISION MEASUREMENT AND CALIBRATION: IMAGE OPTICS"
National Bur. of Stand., Washington, DC (1973)

The volume is one of an extended series which brings together the previously published papers, monographs, abstracts, and bibliographies by NBS authors dealing with precision measurement of specific physical quantities and the calibration of the related metrology equipment. The contents have been selected as being useful to the standards laboratories of the United States in tracing to NBS standards the accuracies of measurement needed for research work, factory production, or field evaluation. The volume deals with image optics, including photography. It contains 62 reprints assembled in 4 sections: (1) Refractometry and Optical Homogeneity, (2) Interferometry in Image Optics, (3) Optical Design and Image Evaluation, (4) Photographic Science. Each section is introduced by an interpretive foreword.

Descriptors: OPTICAL IMAGES; PHOTOGRAPHIC IMAGES; MEASUREMENT; REFRACTOMETERS; OPTICAL METERIALS; OPTICAL GLASS; REFRACTIVITY; INTERFEROMETERS; OPTICAL LENSES; PHOTOGRAPHIC LENSES; OPTICAL FILTERS; CAMERAS; CALIBRATING
Identifiers: PRECISION MEASUREMENT; NBS

MCCROBIE, G.L. and MITCHELL, L.L.
"AGREEMENT BETWEEN COMPUTED MTF DESIGN AND MTF MEASUREMENTS FOR A 1X COPY LENS"
Optical Soc. America (1972)

Prototype and production lens evaluation using MTF techniques is a reality. God conformance between the computer analysis of a lens design and MTF bench measurements is being achieved. This paper discusses the computation procedures and evaluation methods used in obtaining this correlation for a 25-CM F/5.6, 1′ 1 copy lens

Descriptors: OPTICAL DESIGN TECHNIQUES; LENSES; TRANSFER FUNCTIONS

Identifiers: MODULATION TRANSFER FUNCTION; COMPUTED MTF DESIGN DATA; BENCH MEASUREMENTS; 1X COPY LENS; COMPUTATION PROCEDURES; EVALUATION METHODS

MCDONALD, R. and OSTERBERG, H.
"DIFFRACTION IMAGES PRODUCED BY FULLY CORRECTED OBJECTIVES OF HIGH NUMERIAL APERTURE"
Optical Image Evaluation, Gardner, I. (1954)

No abstract provided.

MOORE, R., SLAYMAKER, F.H., and HOPKINS, R.E.
"PRODUCTION LENS QUALITY EVALUATION BY THE SIMULTANEOUS MEASUREMENT OF THE OTF AT THREE FIELD POINTS"
Opt. Eng., 12, 155 (1973)

Methods are discussed for testing and evaluating lenses to determine how well the lens fulfills its designed function over the entire field. The actual image testing system for testing production lenses is described in detail (6 Refs.).

Descriptors: LENSES; OPTICAL TESTING; OPTICAL VARIABLES MEASUREMENT; OPTICAL IMAGES

Identifiers: LENS QUALILTY EVALUATION; OTF; THREE FIELD POINTS; TESTING; IMAGE TESTING SYSTEM; PRODUCTION LENSES

MOORE, R. and SLAYMAKER, F.H.
"OTF EVALUATION OF LENSES, NOT IMAGES"
J. Opt. Soc. Am., 63, 1276 (1973)

A system has been developed that measures the OTF of a heterochromatic image at both S and T orientation and through focus with no operator intervention. The system has been extended to measure multiple field points simultaneously, permitting real-time evaluation of the complete imagery properties of an optical system. System philosophy, scanner design, computer operation, and system performance are discussed.

Descriptors: OPTICAL TESTING; LENSES

Identifiers: HETEROCHROMATIC IMAGE; SYSTEM PHILOSIOPHY; SCANNER DESIGN; COMPUTER OPERATION; SYSTEM PERFORMANCE; OPTICAL TRANSFER FUNCTION

MURATA, K., FUJINO, Y., MIYATA, S., MATSUI, H., and SEKINE, Y.
"DEVELOPMENT AND IMPLEMENTATION OF INSTRUMENTS FOR MEASURING OPTICAL TRANSFER FUNCTION OF LENSES"
Dept. of Appl. Phys. Faculty of Eng., Hokkaido Univ. (1976)

Describes a method to evaluate the imaging performances of a lens on a resonable criterion and to test the lens accurately as well as speedily. At any early stage the authors adopted optica transfer function (OLTF) as a criterion for lenses. The method for measuring OTF of lenses is studied and a new, accurate and rapid method is developed. On the basis of this idea, the authors developed OTF measuring instruments and implemented them for practical use. In this report, the objectives, the progress, the details and the results of the research are described.

Descriptors: LENSES; OPTICAL TRANSFER FUNCTION; OPTICAL TESTING

Identifiers: MEASURING OPTICAL TRANSFER FUNCTION; LENSES; MEASURING ISTRUMENTS; OPTICAL TESTING; LENS EVALUATION; IMAGING PERFORM ANCE EVALUATION

NAKAMURA, T., SEKINE, Y., NITO, T., and OSE, T.
"OTF STANDARDIZATION IN JAPAN"
Soc. Photo-Optical Instrumentation Eng. (1976)

In order to advance the practical use of OTF in specifying and evaluating the performance of optical systems, especially photographic lenses. The working group on OTF standards is now engaged in OTF standardization. Three drafts have already been made concerning OFT definition,

graphical representations and accuracy of measuring instruments. Now the group are planning to make a draft of OTF measurement processing and carrying out fundamental research on the white light standard (6 Refs.).

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; OPTICAL INSTRUMENT TESTING; MEASUREMENT STANDARDS; PHOTOGRAPHIC LENSES; LENSES

Identifiers: OTF STANDARDIZATION; JAPAN; OPTICAL SYSTEMS; PHOTOGRAPHIC LENSES; OFT DEFINITION; GRAPHICAL REPRESENTATIONS; ACCURACY OF MEASURING INSTRUMENTS; OTF MEASUREMENT PROCESSING; WHITE LIGHT STANDARD

NITOU, T.
"INTERLABORATORY COMPARISON OF MTF MEASUREMENTS IN JAPAN"
Soc. Photo-Optical Instrumentation Eng. (1976)

The working group of Japan Optical Engineering Research Association (JOERA) was organized in 1974 and made interlaboratory comparisons of MTF measurements and OTF standardization. MTF measurements were taken at eight to ten places, using two standard lenses. Standard lens II′ Petzval Type, F/2, F=50 MM. Infinite conjugate angular field up to 5 degrees, lambda=546 NM. Standard lens III′ Gauss Type, F/2.8. F=50 MM. Infinite conjugate angular field up to +or- 25 degrees. Lambda 546 NM. as a measure for international comparison, SIRA Institute and JOERA exchanged their standard lenses and performed measurements. The results of MTF measurements showed good coincidence on the axis. But the spread of Max. +or- 0.15 off the axis. The cause of this error has been examined. The measurement using monochromatic light except E-line and white light does not show good coincidence. The author intends to investigate this subject in both calculation and measurement (3 Refs.).

Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; PHOTOGRAPHIC LENSES; MEASUREMENT STANDARDS

Identifiers: MTF MEASUREMENTS; JAPAN; MONOCHROMATIC LIGHT;

INTERLABORATORY COMPARISON; PETZVAL TYPE STANDARD LENS; GAUSS TYPE STANDARD LENSES; PHOTOGRAPHIC LENS; OTF STANDARDIZATION

NUZHIN, V.S.
"EFFECT OF OPTICAL BENCH VIBRATIONS ON TESTING OF LONG FOCAL LENGTH LENSES"
Sov. J. Opt. Technol., 36, 468 (1969)

Measurements of the vibrations of images of test objects in the focal plane of long focal length lens are described, together with the setup use for the measurements. The effect of image vibrations on visual and photographic recording is estimated. Stability specifications on the optical bench are given.

Descriptors: OPTICAL IMAGES; OPTICAL INSTRUMENTS; LENSES; VIBRATIONS

PLUMMER, W.T.
"FAST AUTOMATIC LENS TESTING FOR EXTENDED-FIELD IMAGE QUALITY"
Appl. Opt., 15, 805 (1976)

Describes high speed test for lenses used in Polaroid Land photography. One machine can test 1200 lenses/H. Yield functions for a hypothetical lens shows relative effect of field curvature and field tilt upon qualilty distribution in a population of lenses. MTF and RMS blur are considered (8 Refs.).

Descriptors: OPTICAL TESTING; PHOTOGRAPHIC LENSES

Identifiers: HIGH SPEED TESTS; POLAROID LAND PHOTOGRAPHY; FIELD CURVATURE; FIELD TILT; QUALITY DISTRIBUTION; MTF; RMS BLUR; EXTENDED FIELD IMAGE QUALITY; YIELD FUNCTIONS; FAST AUTOMATIC LENS TESTING

POLEAU, J.
"MODULATION TRANSFER FUNCTION MEASUREMENT OF OPTICAL SYSTEMS IN THE VISIBLE AND INFRA-RED 95 TO 20MUM) RANGE"
Opt. Acta, 22, 339 (1975)

The ACOFAM combines an optical method of frequency analysis with electronic data unit and display to obtain a fast and accurate measurement of the modulation transfer function of lenses and complete systems in the visible range. Some extra devices are described in order to convert the standard ACOFAM tothe infra-red spectral range (5-20 MUM). Results of measurements on a 50 MM/1 developed by the optical division of engine matra are shown.

Descriptors: TRANSFER FUNCTIONS; OPTICAL SYSTEMS; OPTICAL INSTRUMENTS; LENSES

Identifiers: IR; 5 to 20 MICRONS; ACOFAM; MODULATION TRANSFER FUNCTION MEASUREMENT; OPTICAL SYSTEMS; VISIBLE; FREQUENCY ANALYSIS; ELECTRONIC DATA UNIT AND DISPLAY; LENSES

SCHADE, O.H.
"A NEW SYSTEM OF MEASURING AND SPECIFING IMAGE DEFINITION"
Optical Image Evaluation, Gardner, I. (1954)
No abstract provided.

SCROGGIE, A.A. and TINDALL, J.W.
"GENERAL OPTIMIZATION AND IMAGE-EVALUATION COMPUTER PROGRAM"
Opt. Soc. Americal (1969)
Abstract only given substantially as follows. A new lens-optimization program based on a given optical-transfer function together with a new optical-evaluation random-sampling technique is described. If the OTF is given, the program will select an appropriate design to meet the specifications. The program is capable of adding and subtracting elements and aspheric surfaces upon request. During this process, the program will continuously convey information to the user as to the progress of the optimization. The evaluation section computes the irradiance profile on an imaging surface generated by any finite extended source. the influences of intermediate elements that act as sun shades, baffles, or structural members can be included. Surface-edge effects, paint imperfections, random dust-scattering, scratches, and bubbles can also be accounted for.
Descriptors: LENSES; CALCULATING APPARATUS; DIGITAL COMPUTER PROGRAMS; OPTICS; UTILITY PROGRAMS; OPTIMIZATION; COMPTER AIDED DESIGN

SHACK, R.V.
"A PROPOSED APPROACH TO IMAGE EVALUATION"
Optical Image Evaluation, Gardner, I. (1954)
No abstract provided.

SHAW, R.
"SELECTED READINGS IN IMAGE EVALUATION"
Appl. Opt., 16, 2399 (1977)
This publication is a volume of selected reprints, many of which have been published over the years in Photographic Science and Engineering. The Society, which recently formed an SPSE Technical Section in Image Evaluation, felt that there was a need for such a collected-papers volume since books dealing adequately with the subject seem to be relatively few in number.

SHULMAN, M.Y., SOKOLOVA, N.N., VASILYEV, Y.V., and SHERAJERDINOVA, O.V.
"INSTRUMENT FOR MEASURING MODULATION TRANSFER FUNCTIONS OF VARIOUS OBJECTIVES"
Sov. J. Opt. Technol., 40, 431 (1973)
An optical bench with interchangeable collimators is used to test objectives by harmonic analysis of the image produced. The theory of the measurements is described and full details, mechanical and electrical, of the instrument, are given. Measurements of MTF's of several objectives are presented graphically. Absolute error of MTF is not greater than +or- 0.05 (9 Refs)
Descriptors: OPTICAL TESTING; OPTICAL INSTRUMENTS; LENSES
Identifiers: MODULATION TRANSFER FUNCTIONS; OBJETIVES;

OPTICAL BENCH; INTERCHANGEABLE COLLIMATORS;
HARMONIC ANALYSIS; TESTING; MECHANICAL DETAILS;
ELECTRICAL DETAILS

SILVERTOOTH, E.W.
"HIGH FINESSE INTERFEROGRAMS"
Appl. Opt., 10, 1980 (1971)
No abstract provided.

SIMON, J.
"MEASUREMENT OF THE MTF IN FRANCE"
Soc. Photo-Optical Instrumentation Eng. (1977)
A brief look at the French situation in the TF measurement field is presented. The author describes a method for measuring the MTF of optical systems and the development of a measurement instrument, the ACOFAM. The ACOFAM's field of applicability, originally lmited to the visible spectrum can now be extended to the infra-red range by replacing the source, receiver and optical analyzer modules. Moreover, the MATRA Company which produces the ACOFAM, a very complete instrument especially intended for laboratory use. Currently offers a simplified instrument, "ACOMAT", destined for Insutrial Inspection departments. This instrument enables the modulation of a "standard" optical system to be compatred (for two spatial frequencies) with that of a sample system consisting of the industrial product under study (9 Refs.).
Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL TESTING; LENSES; MEASUREMENT STANDARDS; PHOTOGRAPHIC LENSES; OPTICAL INSTRUMENT TESTING
Identifiers: FRANCE; OPTICAL SYSTEMS; MEASUREMENT INSTRUMENT; ACOFAM; VISIBLE SPECTRUM; LABORATORY USE; ACOMAT; INDUSTRIAL INSPECTION DEPARTMENTS; MTF MEASUREMENT; IR RANGE; LENSES; PHOTOGRAPHIC LENSES

TAKEDA, M. and TAKESI, K.
"MTF MEASUREMENT OF TV ZOOM LENSES: INFLUENCE OF DISTORTION ON THE EQUIVALENCE OF NORMAL AND INVERSE CONJUGATE TECHNIQUES"
Appl. Opt., 17, 2171 (1978)
Influence of distortion is studied with regard to the equivalence of the normal and inverse conjugate techniques used in the measurement of MTF's of TV zoom lenses. The two techniques can be regarded as practically equivalent ony when the local magnification (as distinguished from the conventional paraxial magnification) is utilized in frequency conversion needed in the inverse conjugate technique. A sample TV zoom lens is presented as a numerical example which supports the results of the discussion. A simple method is proposed for determinig the local magnification simultaneously in the process of the MTF measurement.

THACKERAY, D. and WICKES, M.
"SIMPLE TEST FOR PROJECTION LENSES"
J. Photogr. Sci., 22, 306 (1974)
The construction of some simple test slides, and their use in the visual assessment of

the abberrations of projection lenses, is described here. The kinds of aberration, and their magnitudes, if significant in the visual image, can be determined readily.
Descriptors: LENSES: ABERRATIONS
Identifiers: OPTICAL TESTING; PROJECTION LENSES; ABERRATION; IMAGE DEFECTS; SEIDEL ABERRATIONS; CHROMATIC ABERRATION; SPHERICAL ABERRATION; COMA; ASTIGMATISM

VAN LEUNEN, J.A.J.
"OTF (OPTICAL TRANSFER FUNCTIONS) STANDARDIZATION"
Soc. Photo-Optical Instrumentation Eng. (1976)
In 1971, under the auspices of the Dutch Ministry of Defense, a committee started with a standard for the measurement of the MTF of image forming equipment. In a short time, a reasonable and workable standard was produced that covered optical and electrooptical systems. This standard was far from perfect but it did contain so many useful starting points for the working out of an improved satandard that it was presented to a NATO commission which had the task of preparing an OTF standard for the NATO countries as a whole. The author deals further with some interesting aspects of the OTF and with problems encountered in OTF standardization when non perfect imaging devices that have veiling glare, nonisoplanatism or a restricted linear range are considered.
Descriptors: OPTICAL TRANSFER FUNCTION; MEASUREMENT SANDARDS; OPTICAL TESTING; OPTICAL INSTRUMENT TESTING; LENSES
Identifiers: MTF; IMAGE FORMING EQUIPMENT; OTF STANDARDIZATION; NON PERFECT IMAGING DEVICES; VEILING GLARE; NONISOPLANATISM; RESTRICTED LINEAR RANGE; OPTICAL SYSTEMS; ELECTROOPTICAL SYSTEMS

WALKER, B.H.
"PRACTICAL LIMITS OF IMAGE QUALITY FOR NEAR PERFECT LENSES"
Opt. Eng., 12, 152 (1973)
Several typical examples of perfect and near perfect lenses, showing the magnitude of degradation that must be expected are examined. Evaluation is accomplished first by examining the effect on energy distribution within the airy disc pattern. Then, in order to demonstrate the effect on images of extended objects, modulation transfer function data is presented for the same condition. The data indicates that diffraction at the system aperture, particularly where an obscuration is present, and minute residual wavefront imperfections (=lambda/4 OPD), will have an effect on the final system performance that must be taken into account. An improtanct factor in determining the significance of these errors on final system performance would be whether the optics are forming point images or extended images or real world objects.
Descriptors: LENSES; OPTICAL TESTING; OPTICAL IMAGES
Identifiers: IMAGE QUALITY; NEAR PERFECT LENSES; DEGRADATION; ENERGY DISTRIBUTION; AIRY DISC PATTERN; DIFFRACTION; SYSTEM APERTURE; OBSCURATION; MINUTE RESIDUAL WAVEFRONT IMPERFECTIONS; PINT IMAGES; EXTENDED IMAGES; PERFECT LENSES

WASHER, F.E.
"RESOLVING POWER OF AIRPLANE-CAMERA LENSES"
Optical Image Evaluation, Gardner, I. (1954)
No abstract provided.

WILLIAMS, T.L.
"THE OPTICAL TRANSFER FUNCTION CONCEPT"
Phys. Bull., 24, 438 (1973)
The concept, which deals with (Fourier) sinewave analysis of optical systems, is outlined, and its advantages in assessing accurately the performance of lenses are described. Finally a description of OTF measuring equipment is given (7 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; OPTICAL DESIGN TECHNIQUES
Identifiers: OPTICAL TRANSFER FUNCTION; SINEWAVE ANALYSIS; OPTICAL SYSTEMS; PERFORMANCE OF LENSES; FOURIER ANALYSIS

WILLIAMS, T.L.
"AN INSTRUMENT FOR MEASURING THE MTF OF LENSES USED IN THERMAL IMAGING AND OTHER INFARED SYSTEMS (2 to 14 MUM)
Soc. Photo-Optical Instrumentation Eng. (1974)
An instrument is described which can be used for measuring directly the MTF of infrared optical systems operating in the wavelength range 2 to 14 MUM. The instrument uses a moire fringe technique for generating the test target, but a novel arrangment permits measurements at single spatial frequencies as well as over a continuouis range of frequencies. The instrument is designed to give automatic normalization and has facilities enabligh the line spread function to be measured directly (19 Refs.).
Descriptors: OPTICAL INSTRUMENT TESTING; LENSES; INFRARED IMAGING OPTICAL IMAGES; TRANSFER FUNCTIONS
Identifiers: LENSES; THERMAL IMAGING; INFRARED SYSTEMS; INFRARED OPTICAL SYSTEMS; MOIRE FRINGE TECHNIQUE; LINE SPREAD FUNCTION; AUTOMATIC NORMALIZATION

WILLIAMS, T.L.
"ASSESSING THE PERFORMANCE OF LENSES FOR USE IN THERMAL IMAGING SYSTEMS"
IEE, London, England (1975)
The parameters one needs to measure in order to assess the performance of a lens system used in the thermal range of wavelengths do not differ significantly from those measured in assessing visible wavelength systems. The main difference is that visual assessment techniques can no longer be used (unless one is dealling with pure mirror systems) and therefore more complex electro-optical test instruments are required. The present paper described some of the test instruments and techniques which can be used for assessing thermal imaging optical systems and in particular those techniques which have been used by the author (3 Refs).
Descriptors: INFRARED IMAGING; LENSES; OPTICAL TESTING; ELECTRO-OPTICAL DEVICES
Identifiers: LENS PERFORMANCE ASSESSMENT; ELECTROOPTICAL TEST

INSTRUMENTS; THERMAL IMAGING SYSTEMS

WILLIAMS, T.L.
"ASSESSMENT OF IMAGING SYSTEMS"
Soc. Photo-Optical Instrumentation Eng. (1976)
The following topics were dealt with measurement and calculation of OTF. MTF and related criteria; subjective and objective relationships; total system assessment; national and international specifications. 23 papers were presented, of which 20 are published in full in the present proceedings, and 3 as abstracts only.
Descriptors: OPTICAL TRANSFER FUNCTION; OPTICAL IMAGES; OPTICAL TESTING; OPTICAL INSTRUMENT TESTING; MEASUREMENT STANDARDS; LENSES PHOTOGRAPHIC LENSES
Identifiers: OTF; MTF; OBJECTIVE RELATIONSHIPS; TOTAL SYSTEM ASSESSMENT; IMAGING SYSTEM ASSESSMENT; OPTICAL TESTING; LENSES; PHOTOGRAPHIC LENSES; STANDARDIZATION; SUBJECTIVE RELATIONHIPS

WILLIAMS, T.L.
"A SPOT DIAGRAM GENERATOR FOR LENS TESTING"
Opt. Acta, 15, 553 (1968)
An instrument for measuring the geometrical aberration of a lens operates by scanning the lens pupil with a "ray" of light and measuring the coordinates of the ray intersection points in the image plane using a position-sensitive photocell. The ray intersection points are displayed as a spot diagram on a cathode ray tube. Up to 300 rays are traced through the lens in under 1 sec. Facililties are included for automatically counting the total number of rays traced through the lens as well as the number intersecting the image plane within an area defined by four adjustable boundaries. Two detectors are available for the instrument, one covers the visible spectrum and the other the near infra-red.
Descriptors: LENSES; OPTICAL INSTRUMENTS TESTING; ABERRATIONS; OPTICAL

YASHKIN, Y.N.
"ON IMAGE QUALITY INCREASE OF HIGHSPEED MOTION PICTURE PHOTOGRAPHY WITH A PLATE POLYHEDRAL COMPENSATOR"
Tekh. Kino and Telev., 12, 29 (1978)
The procedure for calculating a plate polyhedral compensator used in high speed motion picture cameras is given. It is shown that image displacement linearity for this compensatior is greater than for prismatic ones. The recommendations for image quality evaluation and camera lens choice are also presented (13 Refs.).
Descriptors: CINEMATOGRAPHY; CAMERAS
Identifiers: IMAGE QUALITY; HIGH SPEED MOTION PICTURE; PHOTOGRAPHY; PLATE POLYHEDRAL COMPENSATOR; IMAGE DISPLACEMEDNT LINEARITY; CINEMATOGRAPHY

25 CYLINDRICAL, LENSES, AXICONS, ETC.

ARNOLD, J.B., SLADKY, R.E., STEGER, P.J., WOODALL, N.D., and SAITO, T.T.
"MACHINING NONCONVENTIONAL-SHAPED OPTICS"
Opt. Eng., 16, 347 (1977)

Nonconventional-shaped optics are being machined for use in laser optical systems. The fabrication processes incorporate special-quality diamond tools and specially constructed turning machines. The shapes produced include axicons (conical-shaped mirrors), waxicons (a compound axicon with a "W" cross section), torics, and multifacet mirrors. Whereas conventional-shaped optics are readily producible by the lapping process, these nonconventional-shaped optics are very impractical to lap. The axicons and waxicons produced were estimated to have surface straightness as good as 5 in (125 nm), over 3 inches (76 mm) of length, and angular accuracy as good as 2 arc seconds. A toric mirror was estimated to deviate (peak to valley) from a best-fit radius by 4 in (100 nm) over 2.25 inches (57 mm) of surface length.

DEEVER, W.T.
"PRECISION MEASUREMENTS OF OPTICAL ALIGNMENT USING AN AXICON"
Annual Meeting of the Optical Society of America (1972)

An optical technique has been developed for monitoring relative tilts in multielement lenses. Using this technique, surface tilts of less than five seconds of arc have been achieved in custom-aligned lenses. Light from a laser is directed into the optic to be measured and the fresnel reflections from the lens surfaces are imaged by an axicon. The universal focus characteristic of the axicon allows all images to be examined in the same focal plane. When the optical is rotated about a reference axis, imaged reflections not lying on this axis proces in circless. The radii of the circles are related to the physical tilts of the reflecting surfaces by a matrix equation which may be solved with a small desk-top computer (1 Ref.).

Descriptors: OPTICAL SYSTEMS; OPTICAL INSTRUMENT TESTING; LENSES
Identifiers: OPTICAL ALIGNMENT; AXICON; RELATIVE TILTS; MULTIELEMENT LENSES; LASER; FRESNEL REFLECTIONS

GRASSL, H.
"DETERMINATION OF AEROSOL SIZE DISTRIBUTIONS FROM SPECTRAL ATTENUATION MEASUREMENTS"

An iteration method for the determination of size distributions of aerosols from spectral attenuation data, similar to the one previously published for clouds, is presented. The basis for this iteration is to consider the extinction efficiency factor of particles as a set of weighting functions covering the entire radius region of a distribution. The weighting functions were calculated exactly from the Mie theory. Aerosol distributions are shown derived from tests with analytical size distributions and also generated from measured aerosol extinction data in seven spectral channels from 0.4 mu to 10 mu wavelength in continental aerosols. The influence of relative humidity on the complex index of refraction is also discussed.

HOWLAND, B.
"USE OF CROSSED CYLINDER LENS IN PHOTOGRAPHIC LENS EVALUATION"
Appl. Opt., 7, 1587 (1968)

Two methods are described for testing cameras and camera lenses by utilizing the properties of the crossed cylinder lens, an ophthalmic test device. In the first, the cylinder lens is used in conjunction with a rectangular grid to defocus the star image formed by a collimator. This test permits quantitative determination of axial chromatic aberration, spherical aberration and its variations with wavelength, and coma of the lens. In the second, a segment of the cylinder lens is used as a supplmenetary lens attachment to the camera, which photographs a polar coordinate chart. Analysis of the photograph permits determination of the sagittal and tangential field curvatures, and also indicates errors in focal adjustment and misalignment of film plane with respect to the lens axis (17 Refs.).

Descriptors: LENSES/PHOTOGRAPHIC

LOOMIS, J.S.
"ANALYSIS OF INTERFEROGRAMS FROM WAXICONS"
SPIE, 171 Optical Components (1979)

Axicon elements are used in cylindrical optical systems such as high-power chemical lasers. Interferometric tests of such elements cannot be interpreted by standard methods. Axicon aberrations of cone error and decenter error are defined to help interpret such interferograms. A preprocessing option was added to FRINGE to treat axicon data. An example interferogram has been analyzed.

MACFARIANE, M. and FLINT, G.
"DIAGNOSTIC TECHNIQUES FOR AXICONS AND RELATED OPTICS"
International Laser Systems, Inc., Albuquerque, NM (1979)

The use of axicons and related types of optical components is of increasing important in high energy laser systems. To aid in the acceptance testing of these optics, a program for the development of diagnostic tools and techniques for axicon evaluation has been undertaken by the Developmental Optics Facility at the Air Force Weapons Laboratory. Analytical models describing both the wavefronts and farfield patterns of systems containing axicons have been developed. These models have been used to derive methods for testing axicons in the laboratory. They have also been used to develop suggestions for the initial parameter specifications of axicons. Finally, methods for the correction of certain types of axicon aberrations due to fabrication errors are discussed.

MANSELL, D.N., and SAITO, T.T.,
"DESIGN AND FABRICATION OF A NONLINEAR WAXICON"
Opt. Eng., 16 355 (1977)

This paper describes the theory, design and fabrication of a complementary pair of cone-like mirrors which transform an annular collimated laser beam into a gaussian profiled collimated beam without obscuration.

The details of a simple computer algorithm are revealed which explain the numerical procedure for computing the coordinates of the mirror surfaces. Also discussed is the procedure to diamond turn the nonlinear surfaces using the development lathe at the ERDA Y12 Plant and the metrology of the first parts produced.

SOSNOV, A.N., FILIMONOVA, Z.K., and CHUNIN, B.A.
"THE TESTING OF OPTICAL COMPONENTS WITH CYLINDRICAL SURFACES"
Sov. J. Opt. Technol., 39, 309 (1972)
The testing of cylindrical lenses is considered (1 Ref.).
Descriptors: OPTICAL TESTING; LENSES
Identifiers: OPTICAL COMPONENTS WITH CYLINDRICAL SURFACES

SOSNOV, A.N., KUZNETSOV, S.M., and ZUBAKOV, V.G.
"NEW INSTRUMENTS FOR TESTING CYLINDRICAL LENSES"
Sov. J. Opt. Technol., 40, 245 (1973)
Instruments for (1) simultaneous determination of rotation angle of generatrices and taper of cylindrical lenses and for (2) testing the angle of rotation are described. Photographs are reproduced and simple theory discussed. Prototype instruments are of equal precisson (20 - 30 seconds) to conventional goniometer spectrometers but with a 5 fold saving in measurement time for the first instrument and have accuracy of 25-30 seconds for the second instrument (3 Refs.).
Descriptors: OPTICAL TESTING; LENSES
Identifiers: TESTING; CYLINDRICAL LENSES; ROTATION ANGLE; GENERATRICES; TAPER; EQUAL PRECISION; CONVENTIONAL GONIOMETER; SPECTROMETERS; SPECTROMETERS; MEASUREMENT TIME; PHOTOGRAPH

AUGUSTYN, W.H.
"AUTOMATIC DATA REDUCTION OF BOTH SIMPLE AND COMPLEX INTERFERENCE PATTERNS"
Zygo Corporation, Middlefield, Connecticut (1979)

This paper describes an automatic pattern processor which can be utilized for reducing both simple and complex interference patterns derived from high quality optical surfaces. The complex patterns may be produced either by optical interference phenomena or by contour patterns obtained from either holographic or Moire techniques.

The rapid, accurate measurement and analysis of even simple interference patterns has heretofore been tedious and time consuming due to the unavailability of objective, affordable instrumentation. In practice, many interference patterns can have poor contrast, such as in some Moire or holographic tests; large fringe deviations, such as in aspheric testing; and high spatial frequency deviations, as with diamond turned surfaces. For those cases, the measurement problems become significantly more formidable.

BERENS, A.S.C. and WELTER, R.A.
"AUTOMATIC TESTING OF ELECTROOPTICAL SYSTEMS"
Appl. Opt., 9, 2298 (1970)

The ever-increasing demand for test equipment which can interface with a computer or which can perform operationally in a completely automatic mode has had a large effect on the somewhat futuristic question: "How do we test electrooptical systems automatically?" This paper is developed to give information about the systems currently in operation, the techniques required for automation of these systems, the present problem areas of design, and a look at new techniques for future electrooptical systems testing.

GLASSMAN, A.T. and ORR, C.E.
"AUTOMATED INTERFEROGRAM REDUCTION"
University of Dayton Research Institute, Dayton, OH (1979)

The University of Dayton Research Institute has developed a system for the automated reduction of straight-line and circular fringe patterns. The system was designed for the Air Force Weapons Laboratory at Kirtland Air Force Base and is composed of three major hardware components: an automated pattern processor (ZAPP); a computer-controlled television-based digitizer (EyeCom); and a PDP-11/34 minicomputer.

The ZAPP scans straight-linge fringe patterns, displays the fringe center coordinates, and computer the peak-to-valley and RMS wavefront. The computer processes the fringe coordinates for wavefront analysis. When fully operatonal, the EyeCom will digitize circular fringe patterns, and then the fringe-acquisition program will manipulate the data to provide appropriate inputs for wavefront analysis. Outputs of the computer analysis are wavefront deviation, Seidel aberrations, Zernike coefficients, diffraction intensity spread function, Strehl ratio, optical transfer function, and geometric spot diagrams.

LOOMIS, J.S.
"A COMPUTER PROGRAM FOR ANALYSIS OF INTERFEROMETRIC DATA"
Optical Interferograms--Reduction and Interpretation,
ASTM STP 666, Guenther, A.H. and Leibenberg, D.H., Eds.
American Society for Testing and Materials, pp 71 (1978)
No abstract provided.

JONES, R.A. and KADAKIA, P.L.
"AN AUTOMATED INTERFEROGRAM ANALYSIS TECHNIQUE"
Appl. Opt., 7, 1477 (1968)
An automated technique has been developed for the analysis of various types of interferograms. The technique makes use of a high speed digitized microdensitometer to scan the interferograms and a high speed computer top perform the required computations. The optical thickness variations for a test specimen can be determined by analysis of one or two interferograms. In addition, when required, determinations can be made of time change in opical thickness or the physical thickness and index of refractive homogeneity profiles by analysis of multiple interferograms.

MACGOVERN, A.J. and WYANT, J.C.
"COMPUTER GENERATED HOLOGRAMS FOR TESTING OPTICAL ELEMENTS"
The application of computer generated holograms to the interferometric testing of asphric optical elements have been investigated, and it has been shown that they provide a convenient and practical method of producing an asphric reference wavefront.

MOORE, R.C.
"AUTOMATIC METHOD OF REAL-TIME WAVEFRONT ANALYSIS"
Tropel, Inc., Fairport, NY (1979)
A technique for real-time measuremennt of interferograms is described which circumvents the common sources of error in traditional methods of analysis by nulling the interferometer and simultaneously measuring the phase over a rectilinear grid, error due to geometric distortion in the interferometer (which produces apparent coma terms in the analsis of straight line interferograms), uneven pupil illumination (which shifts the apparent location of the fringe peaks), and the difficulty in fitting and interpolation of polynomials to unevenly sampled pupil functions are elminated. Data are not interpolated or artificially smoothed, so localized irregularities in the wavefront are visible in the results. Because on-line computer processing is used, contour and isometric plots are displayed less than two minutes after data taking is completed. A unique interface design permits utilization of virtually all of the information present in the input video signal. By taking thousands of measurements per minute at each point in the wavefront, and extending the measurments over several minutes, the effects of vibrational and turbulence are averaged out of the data. With a reasonably stable interferometer, the effective instrument bandwidth can be reduced to 0.01 Hz providing worst point peak-to-peak repeatabilities of successive measurements of better than lambda/100. For repeatabilities of lambda/20, data taking times can be reduced below two seconds.

MOTTIER, F.M.
"MICROPROCESSOR-BASED AUTOMATIC HETERODYNE INTERFEROMETER"
United Technologies Research Center, East Hartford, CT (1979)

The inerferometer described in this article combines a number of principels known for a long time in a system of unusual versatility. The operationn modes range from classical interferometry for visual or photographic evaluation of apertures up to 150 mm diameter, to programmed scan heterodyne interferometry with fringe counting and to time- and space-resolved subfringe measurement with better than 10 nm resolution. The instrument is primarily intended as a diagnostiror tool in adaptive optics to monitor the deformable corrector miror during operations.

PARSONS, J.R.
"TESTING A LENS-EVALUATION PROGRAM"
Spring Meeting of the Optical Society of America (1972)

Considers one of several programs that give information about the exit-pupil wave-front error (W), point spread function (PSF), and optical transfer function (OTF) in the course of digitally analyzing the prformance of an optical system. The polypagos program uses two-dimensional fourier transforms of the pupil function to yield the PSF, which in turn is transformed to give the OTF; to date, this program has been evaluated in its ability to compute diffraction-limited PSF and OTF. The simplicity and elegance of third-order aberration theory can be used to generate optical systems having specific amounts of wave-front deformation and these systems can in turn be evaluated by the program to give PSF-OTF data. This paper documents a series of tests which evaluate the ability of the program to compute an OTF in the presence of given amounts of primary or third-order aberration, defocus, central obscuration and polychromic illumination; in most cases the analytic OTF expressions given by steel are used for comparison Also reports the PSF computational accuracy when third-order astigmatism is present and the modulation-transfer-function (MTF) analysis of a heliar lens (4 Refs.).

Descriptors: LENSES
Identifiers: LENS EVALUATION PROGRAM; EXIT PUPIL WAVE FRONT ERROR; POINT SPREAD FUNCTION; OPTICAL TRANSFER FUNCTION; THIRD ORDER ABERRATION THEORY; DEFOCUS; HELIAR LENS; OPTICAL SYSTEM; CENTRAL OBSCURATION; POLYCHROMIC ILLUMINATION; ASTIGMATISM

RIMMER, M.P., KING, C.M., and FOX, D.G.
"COMPUTE PROGRAM FOR THE ANALYSIS OF INTERFEROMETRIC TEST DATA"

The over-all design and capabilities of several proprietary computer programs to reduce and analyze various types of interferometric data are described. The following problems and mehods of solution are discussed in greater detail: scaling and mapping errors; generation of artificial interferograms and holograms for testing without null lenses; combinations of overlapping partial-aperture interferograms; the Ritchey-Common test for flat mirrors; and fitting of interf rometric data with orthogonal polynomials.

SCHULTE, D.H.
"A HARTMANN TEST REDUCTION PROGRAM"

A generalized Fortran program for the reduction of Hartmann test data has been written. A brief review of the mathematical technique is given, along with a discussion of the measuring methods and the results of some tests of the accuracy of the program.

TICHENOR, D.A. and MADSEN, V.P.
"COMPUTER ANALYSIS OF HOLOGRAPHIC INTERFEROGRAMS FOR NONDESTRUCTIVE TESTING"
Sandia Laboratories, Livermore, CA (1979)

We have developed an automated techique for interferogram interpretation using a PDP-12 minicomputer. Cohu television camera and Hughes scan converter. A digitized image of the interferogram is stored on disc, and a small area is read into central memory. The fringe density in that region is estimated based on the number of peaks found in several lines scans across the area under study. This calculation is repeated for successive small areas until a map of fringe density covering the entire part is compiled. If the fringe density map falls within an acceptance profile, the part is accepted. Experimental results demonstrate that the technique works well on interferograms having substantial variations in intensity and fringe contrast.

APPENDIX

BIBLIOGRAPHY ON THE TESTING OF OPTICAL SURFACES

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H. J. Caulfield
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William Friday
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US Army Missile Command
Redstone Arsenal, Alabama

PREFACE

Starting from the publication by Malacara, Cornejo and Murty[1] (1975), a complementary and more recent bibliography on the testing of optical surfaces is presented here. The period reviewed covers mainly from 1975 to 1980, but there are some references previous to 1975 and others corresponding to 1981.

Obviously, there may be some references that are not included, and probably some of them are important, but it is almost impossible to avoid some faults in the task of compiling a bibliographical work.

The same heading division (of the above mentioned publication) of twenty sections is maintained, but two more sections have been added to cover the areas of evaluation, computing and detection for the information provided by the different tests.

An asterisk (*) in the reference means that it is also mentioned in another section; the mark (†) means that the paper is not directly related to optical testing, but the technique can be adapted somehow to the testing. Some of these related fields are adaptive optics, infrared, lasers, and speckle interferometry. The letters A, B, C, and D indicate the subsection of the different main headings.

As a clarifying point, the reference to the Caulfield and Friday[2] paper that appeared in May of the present year was published when the addendum to this appendix was just in a last review stage and ready to be typed.

I am grateful to Mrs. Luz Ma. Olmos for the revision and typing of this report; and to Mr. José Vázquez for the photocopy work performed.

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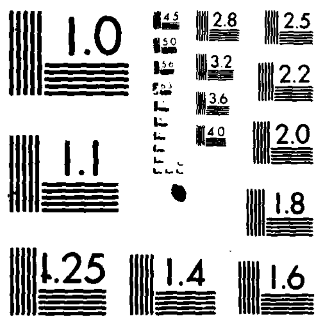

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