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ABSTRACTS OF AIR FORCE MATERIALS LABORATORY REPORTS.(U)
SEP 76 T G PURNHAGEN
UNCLASSIFIED AFML-TR-76-111 NL

1 OF 3
AD A038676



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AFML-TR-76-111

ABSTRACTS OF AIR FORCE MATERIALS LABORATORY REPORTS

OPERATIONS OFFICE

SEPTEMBER 1976

TECHNICAL REPORT AFML-TR-76-111
FINAL REPORT FOR PERIOD JANUARY 1975 - DECEMBER 1975

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This report was prepared by the Scientific and Technical Information Office (STINFO), Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio, under job number 73810328. Tom G. Purnhagen, Lt. Col., USAF (AFML/DOC) was the project monitor.

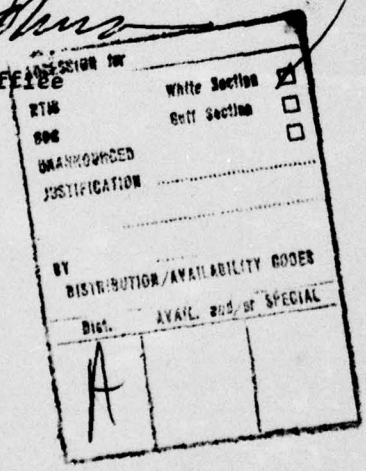
This report has been reviewed by the Information Office (IO) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

TOM G. PURNHAGEN, Lt. Col., USAF
Project Monitor

FOR THE COMMANDER

WARREN P. JOHNSON
Chief, Operations Office



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Technical reports published by the Air Force Materials Laboratory during the period 1 January 1975 - 31 December 1975 are abstracted herein. They are presented in groups corresponding to the divisions of the Laboratory. In addition to the abstract text, the report number, author, AFML project monitor, contractor, contract number, AFML project/task number, report date, and MIC accession numbers are given. Reports on research conducted by the Air Force Materials Laboratory personnel as well as that conducted on contract are included.
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A number of indices are included in the report: subject (KWOC), AD accession number, AFML report number, contract number, contractor.

FOREWORD

Technical reports published by the Air Force Materials Laboratory during the period 1 January 1975 - 31 December 1975 are abstracted herein. Reports on research conducted by Air Force Materials Laboratory personnel as well as those conducted on contract are included. The abstracts are separated into sections corresponding to the divisions of the laboratory with seven indices provided. The accession number cited with each abstract provides access to the document itself in the Air Force Materials Laboratory's document collection.

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ABSTRACTS OF TECHNICAL REPORTS

OPERATIONS OFFICE (AFML/DO)

REPORT NO: AFML-TR-74-257 AD A 013 914
ACCESS NO: 203,762 May 1975
TITLE: DATA ACQUISITION AND ANALYSIS OF LONG-TERM THERMO-AGING DEGRADATION DATA
AUTHOR(S): D. Wisnosky, Lt. P. Cockerham, et al.
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Wisnosky (AFML/DOC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Computer support for laboratory experimentation is becoming increasingly important in all types of scientific research. The more complex an experiment becomes, the greater the need for computer calculation, control, and data acquisition. This report describes a particular data acquisition instrument control application to an experiment in "Thermo-aging". Emphasis has been placed on installation and operation to aid in future applications of the data acquisition system.

REPORT NO: AFML-TR-75-75 AD A 017 860
ACCESS NO: 204,023 August 1975
TITLE: ABSTRACTS OF ACTIVE CONTRACTS, AIR FORCE MATERIALS LABORATORY
AUTHOR(S): N/A
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Wisnosky (AFML/DOC)
DIST. STATEMENT: Approved for public release; distribution unlimited
ABSTRACT: Abstracts of Air Force Materials Laboratory Contracts that were active on 05 February 1975 are reported. Each abstract entry provides the title of the contract, contractor, duration, AFML project engineer, objective and progress or approach in the case of new contracts where there is no progress to report yet.

REPORT NO: AFML-TR-75-123 AD A 019 454
ACCESS NO: 204,111 September 1975
TITLE: ABSTRACTS OF AF MATERIALS LABORATORY REPORTS, JANUARY 1974 - DECEMBER 1974
AUTHOR(S): N/A
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Wisnosky (AFML/DOC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Technical reports published by the Air Force Materials Laboratory during the period 1 January - 31 December 1974 are abstracted herein. They are presented in groups corresponding to the divisions of the Laboratory. In addition to the abstract text, the report number, author, AFML project monitor, contractor, contract number, AFML project/task number, report date, and AFMIC accession numbers are given. Reports on research conducted by the Air Force Materials Laboratory personnel as well as that conducted on contract are included.

ADVANCED DEVELOPMENT DIVISION (AFML/LC)

REPORT NO: AFML-TR-73-152 AD B 004 689
ACCESS NO: 69,611 May 1973
TITLE: ADVANCED DEVELOPMENT ON VULNERABILITY/ SURVIVABILITY OF ADVANCED COMPOSITE STRUCTURES
AUTHOR(S): H. Clark
CONTRACT NO: F33615-71-C-1414
CONTRACTOR: McDonnell Aircraft Corporation
PROJECT MONITOR: R. Neff (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: An experimental and /analytical program was conducted to determine the effect of environmental and operational damage on composite empenage structure. The threshold strength, i.e., the preload stress at which ballistic impact will cause catastrophic failure was also established. It was determined that the threshold strength was lower than the residual strength of ballistically damaged unloaded composites. The study also provided considerable insight into repair methods for composites. The effectiveness of integrally bonded aluminum wire mesh in protecting boron and graphite/epoxy composites was also demonstrated on large subcomponent beams and a full scale horizontal tail. A 120-mesh aluminum coating was found to be effective against direct lightning strikes of 200 kA intensity with a discharge of 100 coulombs.

REPORT NO: AFML-TR-75-51 Vol.I AD B 006 906L
ACCESS NO: 203,825 May 1975
TITLE: LIFE ASSURANCE OF COMPOSITE STRUCTURES VOL.I MOISTURE EFFECTS
AUTHOR(S): J. Halkias, E. McKague, J. Reynolds
CONTRACT NO: F33615-73-C-5104
CONTRACTOR: General Dynamics
PROJECT MONITOR: A. Davis (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Volume I describes tests that were conducted to determine rates and extent of moisture absorption by graphite-epoxy composites. Procedures were developed for accelerating moisture exposures so that years of environmental service could be simulated within a few months. An empirical math model was developed which can predict moisture absorption behavior under realistic or accelerated exposure conditions. Tests were also conducted to determine whether aircraft flight conditions cause changes in moisture absorption behavior. These investigations show that graphite-epoxy composites absorb moisture until an equilibrium level is reached which is proportional to relative humidity. Simulated flight conditions do not cause significant drying of the laminates. In fact, brief exposures (4-5 minutes) to supersonic heating temperatures cause significant increases in the amount and rate of subsequent moisture absorption. Subsonic temperatures, however, cause no detectable change in diffusion behavior.

REPORT NO: AFML-TR-75-78
ACCESS NO: 69, 613 May 1975
TITLE: F-15 COMPOSITE WING VOL I - DEVELOPMENT AND TEST RESULTS
VOL II - DEVELOPEMENT AND TEST RESULTS
AUTHOR(S): A. Pedersen, et al
CONTRACT NO: F33615-71-C-1536
CONTRACTOR: McDonnell Aircraft Corporation
PROJECT MONITOR: D. Roselius (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: An experimental F-15 wing containing a main torque box structure comprised mainly of boron/epoxy and graphite/epoxy is developed and demonstrated ready for flight. Good experimental correlations to design predicted values confirm adequate flutter speed margins and the wing's freedom from divergence instability. The composite wing design is 418 pounds lighter than the counterpart production metal wing. A noteworthy manufacturing accomplishment was the cocuring of the upper and lower sandwich cover skin assemblies. Economical machnining/drilling techniques for boron/epoxy and graphite/epoxy laminates were demonstrated to consistently produce high tolerance, delamination free holes in boron/epoxy and graphite/epoxy laminates.

REPORT NO: AFML-TR-75-113 AD A 018 745
ACCESS NO: 204,096 October 1975
TITLE: RELIABILITY AND RISK ASSESSMENT METHODS AND REDUNDANT STRUCTURES
AUTHOR(S): J. McCarthy, O. Orringer, R. Peterson, K. Seppanen
CONTRACT NO: F33615-70-C-1131
CONTRACTOR: Aeroelastic and Structures Research Lab, MIT
PROJECT MONITOR: Lt. G. Hollingsworth (AFML/LC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The historical background of risk assessment activities concerning the USAF fleet is reviewed and the flaw-growth and wear-out approaches to material behavior are discussed to place the present work in perspective. A new definition of two categories of risk assessment probability calculation is proposed. The second category, which estimates risk due to strength degradation in an aging structure is shown to require accounting for mechanical redundancy if accurate assessments are to be made. A new probability modelling procedure is presented. The new procedure accounts for mechanical redundancy by combining a new generalization of Daniel's fiber bundle theory with matrix structural analysis methods.

METALS AND CERAMICS DIVISION (AFML/LL)

REPORT NO: AFML-TR-72-102 PT III
ACCESS NO: 203,562 April 1975
TITLE: STRESS-CORROSION CRACKING OF METALLIC MATERIALS. PT III, HYDROGEN ENTRY AND EMBRITTLEMENT IN STEEL
AUTHOR(S): M. Fontana, R. Staehle
CONTRACT NO: F33615-69-C-1258
CONTRACTOR: The Ohio State University Research Foundation
PROJECT MONITOR: C. Lynch, H. Kirkpatrick (AFML/LLN)
PROJECT NO: 7312
TASK NO: 731202
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The chemical environment and metallurgical structure play important roles in the entry of hydrogen into iron and steel. In particular, the effect of compounds of sulfur, arsenic, phosphorus, selenium and other elements, generally called "cathodic poisoners," is considered. Their effect is probably related to a perturbation of the surface layer of the metal, and this accelerates the hydrogen absorption kinetics significantly as the number of structural defects increases. The role of pH, electrochemical potential, stress, and temperature on the hydrogen entry kinetics is also considered. The literature regarding the stress corrosion cracking of high-strength steel is reviewed.

REPORT NO: AFML-TR-73-172
ACCESS NO: 202,433 September 1973
TITLE: FRACTURE TOUGHNESS, AGING BEHAVIOR, GRAIN GROWTH, AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS
AUTHOR(S): I. Greenhut, E. Levine, H. Margolin, M. Young
CONTRACT NO: F33615-72-C-1529
CONTRACTOR: Polytechnic Institute of New York
PROJECT MONITOR: L. Bidwell, (AFML/LLM)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The fracture toughness of Ti-5.25Al-5.5V-0.9Fe-0.5Cu was studied for equiaxed alpha-aged beta structures heat treated to produce 0.2% yield stresses of 180,000 psi. As grain increased K_Q was found to decrease then increase. A mechanism is proposed. The structure of Ti-6Al-2Sn-4Zr-6Mo was determined over a range of quenching and aging temperatures by x-ray electron microscopy. Hardness was correlated with structure as a function of aging time. Methods of revealing grain size in a two-phase α-B titanium alloy have been examined and observations on beta grain growth in the presence of alpha have been carried out. The hardness of grain boundary alpha was studied as a function of the thickness of alpha and the hardness of the beta matrix in a Ti-5.25Al--5.5V-0.9Fe-.05Cu alloy.

REPORT NO: AFML-TR-73-247 Vol II
ACCESS NO: 202,045 September 1974
TITLE: PROGRAM TO IMPROVE THE FRACTURE TOUGHNESS AND FATIGUE RESISTANCE OF ALUMINUM SHEET AND PLATE FOR AIRCRAFT APPLICATIONS
AUTHOR(S) D. Thompson, R. Zinkham
CONTRACT NO: F33615-74-C-5060
CONTRACTOR: Reynolds Metals Company
PROJECT MONITOR: Lt. P. Blau (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: The fatigue crack growth rate (FCGR) characteristics of a 7000 series and a 2000 series alloy were evaluated. The bulk of the work was carried out on thermomechanically aged (TMA) RX725 (Al-6Zn-2,5Mg-1.5Cu-.1Zr) and 2048 in the TMA and -T3E9 tempers respectively. Controls included commercial 7975-T6 and 2024-T3 and laboratory-produced 7475-T6 and -T73 and 2124-T351 and -T851.

The results showed a consistent FCGR advantage of RX725-TMA over 7075-T6 and of 2048-T3E9 over 2024-T3.

REPORT NO: AFML-TR-74-198 AD A 014 359
ACCESS NO: 203,804 April 1975
TITLE: RELIABILITY ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON PROBALISTIC INTERPRETATION OF THE SCATTER FACTOR
AUTHOR(S): A. Freudenthal
CONTRACT NO: F33615-74-C-5003
CONTRACTOR: George Washington University
PROJECT MONITOR: R. Donat (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTACT: The "scatter factor" S as used in fatigue design of aircraft is defined as the ratio between the location parameter (estimate) of the "population" of all aircraft, obtained fron n full-scale tests, and the first failure in a fleet of m aircraft. Introducing the Third Asymptotic distribution of smallest values for the fatigue life of the population, this definition produces a Pareto-type distribution of the scatter-factor, on the basis of which S can be related to the number n and m and the reliability level R. Tables of S for different combinations of n, m, R and the "minimum fatigue life" are evaluated. Useful values of the scatter factor for different materials and purposes are suggested.

REPORT NO: AFML-TR-74-203 AD A 014 342
ACCESS NO: 203,807 March 1975
TITLE: A PRELIMINARY STUDY OF FATIGUE CRACK RETARDATION USING LASER INTERFEROMETRY TO MEASURE CRACK SURFACE DISPLACEMENTS
AUTHOR(S): A. Grandt, Jr., W. Sharpe
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: A. Grandt, Jr. (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: A laser interferometry technique is described which is capable of resolving crack surface displacements to a high degree of sensitivity (about 0.1 micron). The method provides continuous measurements of the free surface crackprofile in metal specimens without being limited by rigid body displacements. Using the laser interferometry procedure to determine fatigue crack profiles in 2024-T851 aluminum specimens, it was possible to measure the load at which crack faces completely separate. These opening loads were correlated with peak tensile overloads and subsequent crack retardation. These results are discussed in terms of the Elber concept of fatigue crack closure.

REPORT NO: AFML-TR-74-214 AD A 008 781
ACCESS NO: 203,507 October 1974
TITLE: STRENGTH CHARACTERISTICS OF BORON ALUMINUM COMPOSITE SUBJECTED TO COMBINED STRESSES
AUTHOR(S): R. Thomas
CONTRACT NO: F33615-73-C-5026
CONTRACTOR: Washington University
PROJECT MONITOR: E. Joseph (AFML/LL)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Quasi-static combined stress experiments were performed on 50 v/o unidirectional Al/B composites. The Failure Tensor Polynomial Criterion correlated the experimentally determined failure surface within empirical accuracy. This program has also shown that the compressive axial strength is significantly greater than the tensile axial strength. Combined axial and shear stress fatigue testing has been demonstrated and the results suggest that Al/B composites have good resistance to combined axial-shear fatigue. Preliminary exploration indicates that the stress path may have a significant influence on strength. Additional work in this area is desirable.

REPORT NO: AFML-TR-74-215 AD A 014 361
ACCESS NO: 203,842 May 1975
TITLE: NONDESTRUCTIVE TESTING OF DIFFUSION BONDED TITANIUM ALLOYS FOR ENGINE AND AIRFRAME COMPONENTS
AUTHOR(S): J. Regalbuto, D. Gordon, et al.
CONTRACT NO: F33615-72-C-1705
CONTRACTOR: General Dynamics
PROJECT MONITOR: J. Holloway (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The development and evaluation of ultrasonic instrumentation for the nondestructive testing of diffusion bonded titanium alloy components is described. The fabrication of 600 diffusion bonded specimens containing international deficiencies such as voids, inclusions, lack of deformation, and grain size variations is described. Results are documented of the nondestructive evaluation of a large diffusion bonded titanium structure utilizing blue-etch-anodize, fluorescent penetrant, signal averaged pulse-echo, Delta-Scan, and variable tilt-multiple scan pulse-echo techniques. Defect data resulting from sectioning the large structure are documented.

REPORT NO: AFML-TR-74-224 AD A 005 701
ACCESS NO: 203,344 November 1974
TITLE: DYNAMIC COMPRESSIVE STRAIN RATE TESTS ON SEVERAL GRADES OF BERYLLIUM
AUTHOR(S): T. Nicholas, M. Sever
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: T. Nicholas (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Results of static and dynamic compression tests on several grades of beryllium and lockalloy are presented. A split Hopkinson pressure bar system, used to generate data at strain rates up to 10^3 sec^{-1}, is described in detail. Stress-strain curves show several different grades of beryllium to have a moderate amount of strain rate sensitivity in compression in the plastic region.

REPORT NO: AFML-TR-74-236 AD A 014 795
ACCESS NO: 203,824 May 1975
TITLE: BORON ALUMINUM TITANIUM HYBRID COMPOSITES
AUTHOR(S): E. Joseph
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: E. Joseph (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Roll diffusion bonded tapes of boron-aluminum were interleaved with foils of commerical pure and alloyed titanium and diffusion bonded into plate material. Tensile testing of both longitudinal and transverse specimens indicated a very small drop in longutidinal strength and a dramatic increase in transverse strength to 48.6 ksi and 67 ksi for the Ti-75A and Ti-6Al-4V hybrid, respectively, for annealed unidirectional composites. These transverse strength increases were considerably in excess of rule of mixtures predictions. Metallographic examination of representative material indicated well spaced and adequately bonded material. Direct comparison with similarly bonded unidirectional and cross-plied boron-aluminum plate indicated that, when considering both mechanical properties and composite cost, considerable advantage could be gained through the use of the hybrid composite studied.

REPORT NO: AFML-TR-74-241
ACCESS NO: 203,852 January 1975
TITLE: PRACTICAL SENSITIVITY LIMITS OF PRODUCTION NONDESTRUCTIVE TESTING METHODS IN ALUMINUM AND STEEL
AUTHOR(S): H. Southward, N. Steele, P. Torelli
CONTRACT NO: F33615-72-C-2202
CONTRACTOR: Boeing Commercial Airplane Co.
PROJECT MONITOR: F. Mullins (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes the work accomplished under an 18 month program conducted to evaluate the sensitivity capabilities of current state-of-the-art nondestructive inspection methods. The methods include magnetic particle, penetrant, eddy-current, ultrasonic, and radiographic. These capabilities were demonstrated in response to varied surface flaws and were statistically defined in terms of probability and confidence of detection. This was accomplished with differing specimen configurations in two representative aircraft structural alloys and for both laboratory and production inspections.

REPORT NO: AFML-TR-74-252 AD A 011 647
ACCESS NO: 203,675 April 1975
TITLE: NOTCH TENSILE STRENGTH OF ADVANCED STRUCTURAL GRADES OF BERYLLIUM
AUTHOR(S): T. Nicholas, G. Atkins
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: T. Nicholas (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Room temperature notch tensile of two advanced structural grades of beryllium was determined at quasi-static and high strain rates. Results on P-1 hot isostatically pressed and S-65 hot pressed beryllium indicated that the ductility ratio of Gerard provides a more reasonable approach to design allowables for these materials than tensile elongations for tensile loading in the presence of notches. Ductility ratios of .138 for P-1 and .058 for S-65 were found to represent these materials adequately for values of the theoretical elastic stress concentration factor less than five.

AFML/LL

REPORT NO: AFML-TR-74-255 AD A 008 532
ACCESS NO: 203,457 November 1974
TITLE: GRAIN REFINEMENT OF TITANIUM ALLOYS
AUTHOR(S): M. Buczek, G. Hall
CONTRACT NO: F33615-73-C-5106
CONTRACTOR: RMI Co.
PROJECT MONITOR: M. Greenfield (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program was to determine the optimum amounts of yttrium added either as the oxide or element for grain refinement to commercial Ti-6Al-4V and Ti-38-6-44 titanium alloys and establish the effects on subsequent mechanical behavior and sonic inspectability. The properties of cast 8-inch diameter ingots as well as 3-inch bar processed from these ingots were evaluated at yttrium data were obtained on alloys containing 0.03 percent yttrium. At this level, significant grain refinement was not observed in Ti-38-6-44 although improved sonic inspectability, higher transverse ductility and improved stress-corrosion resistance were observed. At the same 0.03 percent yttrium content, the recrystallized Ti-6Al-4V beta grain size was reduced and improved sonic inspectability and ductility were obtained in wrought and cast products.

REPORT NO: AFML-TR-74-265 AD A 013 880
ACCESS NO: 203,776 April 1975
TITLE: OXIDATION BEHAVIOR OF TITANIUM ALLOYS UNDER HIGH HEATING RATES
AUTHOR(S): J. Wolf
CONTRACT NO: F33615-73-C-5151
CONTRACTOR: Clemson University
PROJECT MONITOR: S. Lyon (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The initial stages of reaction of unalloyed titanium, Ti-6Al-4V Ti8Mn, and -111 titanium alloy specimens with oxygen, nitrogen, and atmospheres bearing these gases has been studied over the temperature range from 800° to 1300° C. The kinetics of these reactions were analyzed for specimens subjected to linear heating rates in the range from 0.5° to 100° C/s. Mathematical techniques were devised for modeling: 1) the oxygen uptake by unalloyed titanium during heating, and 2) the deposition of the chemical heat of reaction into oxidizing substrates.

REPORT NO: AFML-TR-74-269 AD A 011 717
ACCESS NO: 202,168 January 1975
TITLE: EXPLORATION OF STATISTICAL FATIGUE CHARACTERISTICS OF 0.063 - INCH MILL-ANNEALED Ti-6Al-4V SHEET AND 0.050-INCH HEAT-TREATED 17-7 PH STEEL SHEET UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING
AUTHOR(S): J. Butler, D. Rees
CONTRACT NO: F33615-72-C-2003
CONTRACTOR: Boeing
PROJECT MONITOR: R. Donat (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: A total of 17 mill-annealed Ti-6Al-4V 0.063-in. sheet and 14 heat-treated 17-7PH steel 0.050-in. sheet, unique multidetail specimens were fatigue tested under a flight-by-flight loading spectrum to develop a data base for investigating the statistical materials/structures fatigue failure characteristics of these two alloys. In several cases, test specimens of the relatively hard 17-7PH steel fractured before initiated cracks or initial flaws were detected. At open hole structural simulators, detected fatigue cracks were removed by oversizing. The initiation data were examined by maximum likelihood methods for both log-normal and Weibull distributional representation. At a 0.50 reliability level, the results did not show an obvious advantage for either distribution, but on increased levels of reliability, the Weibull distribution was a significantly more conservative simulation of the test data, which showed less variability than that estimated in a previous study.

REPORT NO: AFML-TR-74-273 AD B 005 585 L
ACCESS NO: 203,714 January 1975
TITLE: BASIC RESEARCH ON LASER PLUME CHARACTERIZATION
AUTHOR(S): F. Greene, G. Radolovich
CONTRACT NO: F33615-73-C-5121
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: Capt. A. Grandt (AFML/LLN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: An investigation of the interaction of militarily relevant materials with fluxes of 10.6 μm radiation between 10^2 and 10^4 watts/cm^2 is being carried out. Molecular beam mass spectrometry has been adapted to the sampling of laser plumes formed at atmospheric pressure. A fast data acquisition system has been developed in which the scan of a quadrupole mass spectrometer is synchronized with the molecular beam chopper. Complete spectra can be obtained which have time resolution of the order of 10 msec or better and which include phase sensitive detection. Photography and other techniques have also been used. Preliminary measurements were also made on plumes formed by the irradiation of Plexiglas™ and a graphite-epoxy composite material.

REPORT NO: AFML-TR-74-276 AD A 014 352
ACCESS NO: 203,811 May 1975
TITLE: SOME GENERAL PROGRAMS FOR DESK TOP COMPUTERS
AUTHOR(S): J. Wagner
CONTRACT NO: F33615-73-C-5084
CONTRACTOR: University of Cincinnati
PROJECT MONITOR: O. Srp (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A library of four data analysis programs for the H-P 9820A are presented with operational procedures and complete listings. The library includes a general least squares curve fitting program for polynomials up to degree six with automatic plotting of both the data, fitted curve, and coefficients. In addition a data and function plot program is included which enables efficient plotting of analytic functions and data with control of axis location, labels, and data symbols. Thirdly, a linear regression program is developed which includes a complete statistical analysis of the fitted line. Finally, a general digitizing program is listed which enables quick conversion of graphical information into tabular data without special orientation of the digitizing surface.

REPORT NO: AFML-TR-74-280 AD A 009 172
ACCESS NO: 203,522 January 1975
TITLE: THE ROLE OF TRANSIENT SPECTRUM AND DAMPING ANALYSIS IN ASSESSING THE STRENGTH OF POLYMERIC ADHESIVE METAL BONDING
AUTHOR(S): G. Curtis, A. Joinson, P. Lloyd
CONTRACT NO: AFOSR-73-2523A
CONTRACTOR: Harwell Industrial Research
PROJECT MONITOR: F. Mullins (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes the derivation of an acoustic impact testing facility and some results that have been obtained using it. The primary task has been to examine what acoustic phenomena associated with the response to impact of an adhesively bonded joint relate to the strength of the joint. A "first look" system employing a 40 μ sec contact time impactor, a broadband polymeric foil transducer and a PDP8/I on-line computer has been used to identify the parameters of interest and the most efficient analysis scheme. The analysis has centered around the computation of the fast Fourier transform of the impact response to obtain frequency response spectra and damping information. Initial results using the "first look" system have shown that the presence of artificial defects in rectangular bars can be detected.

REPORT NO: AFML-TR-74-282 AD A 015 001
ACCESS NO: 203,819 May 1975
TITLE: A STRESS INTENSITY FACTOR CALIBRATION FOR CORNER FLAWS AT AN OPEN HOLE
AUTHOR(S): J. Snow
CONTRACT NO: N/A
CONTRACTOR: AFIT
PROJECT MONITOR: Capt. A. Grandt (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This study was an experimental stress intensity factor calibration of a part-thru, corner flaw at an open hole. The fatigue crack growth test was used to investigate corner flaws at holes in polymethylmethacrylate plates loaded in uniform, cyclic tension. It was found that a frequency of 1 or 2 cps could be used for fatigue crack growth in PMMA. In general, this study demonstrated lower stress intensity at the hole and higher stress intensity at the surface for larger crack sizes when compared to other researchers. It was concluded that fatigue crack growth rate testing with PMMA is a useful method of obtaining stress intensity factor calibrations for complex, three-dimensional problems where no exact solutions exist.

REPORT NO: AFML-TR-74-283 AD A 015 002
ACCESS NO: 203,820 May 1975
TITLE: DETERMINATION OF STRESS INTENSITY FACTOR FOR COLD-WORKED FASTENER HOLES IN 7075 ALUMINUM USING THE CRACK GROWTH METHOD
AUTHOR(S): Cathey, W.
CONTRACT NO: N/A
CONTRACTOR: AFIT
PROJECT MONITOR: Capt. A. Grandt (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Stress intensity factor calibrations were obtained for thru-the-thickness flaws emanating from cold-worked fastener holes in 7075-T6 aluminum alloy plate using the fatigue crack growth method. Cracks were periodically photographed to determine crack growth rate using a 35 mm camera actuated by a digital counter. Tests were conducted in laboratory air with constant amplitude loading, 30 Hz frequency, and R-factor=0.05. The J.O. King sleeved cold-working process was used with a nominal diametral interference of 0.012 in. Open-hole specimens were tested at 16 KSI and 40 KSI remote stress. K calibrations for open cold-worked holes were in agreement with Grandt's linear superposition solution. Pin-loaded cold-worked holes, tested using a 2000 lb. load transferred through a 0.25 in. pin, showed a twentyfold increase in fatigue life.

REPORT NO: AFML-TR-75-1 AD A 018 127
ACCESS NO: 204,036 July 1975
TITLE: LOW CYCLE FATIGUE CRACK INITIATION STUDY IN RENE' 95
AUTHOR(S): M. Menon, W. Reimann
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: M. Menon, W. Reimann (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A microstructural study of fatigue deformation and cracking was conducted on Rene' 95 which is a thermomechanically processed superalloy developed for use as disks in advanced gas turbine engines. It was found that the deformation occurred very homogeneously throughout the material. This is believed to be due to the slip dispersive effect of the substructure in the warm worked grains and the very small size of the necklace grains. The study also showed that the number of load cycles to produce crack initiation can be strongly affected by brittle constituents of the microstructure, such as MC carbides. It was found that the specimens that had shorter lives were characterized by MC carbide cracking at the site of the crack initiation, whereas those which had longer lives under the same conditions of loading and temperature were characterized by only slip band cracking with no evidence of MC carbide cracking or decohesion in influencing the initiation.

REPORT NO: AFML-TR-75-2 AD A 013 915
ACCESS NO: 203,774 May 1975
TITLE: MODAL ANALYSIS OF LINEAR NON-CONSERVATIVE SYSTEMS
AUTHOR(S): R. Adkins
CONTRACT NO: F33615-72-C-2113
CONTRACTOR: Universal Technology Corp.
PROJECT MONITOR: Dr. J. Henderson (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Modal methods for analyzing continuous, linear, nonconservative vibrating systems are developed and applied. Both viscous and hysteretic damping are considered and the damping distributions are arbitrary such that the normal modes of the corresponding undamped system will not uncouple the equations of motion of the nonconservative or damped system. Analytical and graphical results are presented for the special case of a pinned-pinned beam with a viscous or hysteretic damping unit at the center of the beam. These results show the uncoupled vibration modes, and the amplitude and phase variation along the beam for uniform harmonic forcing. The results of this investigation are contrasted to the modal methods for conservative systems and it is recommended that nonconservative systems be considered the general vibration problem.

REPORT NO: AFML-TR-75-9 AD A 015 894
ACCESS NO: 203,881 July 1975
TITLE: DEVELOPMENT OF HOT ISOSTATIC PRESSING TECHNIQUES FOR PRODUCING HIGH QUALITY BILLET FROM TITANIUM ALLOY POWDER
AUTHOR(S): G. Friedman
CONTRACT NO: F33615-73-C-5092
CONTRACTOR: Nuclear Metals, Inc.
PROJECT MONITOR: A. Adair (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The contract portion of this program demonstrated the feasibility of producing Ti-6Al-6V-2Sn powder by two different processes. Starting with bar containing 700 to 800 ppm oxygen, hydride dehydride (HD) powder was produced containing 700 to 1200 ppm oxygen. Using input bar from the same heat of metal, powder containing 500 to 800 ppm oxygen was made by the Rotating Electrode Process (REP). Room-temperature-consolidated HD powder and loose REP powder were consolidated by hot isostatic pressing (HIP) under a series of conditions covering 1/2 to 4 hours, 3,750 to 15,000 lb./inch^2, and temperatures 75°F below and above the beta transus. The program results demonstrate that useful engineering properties can be obtained via simple P/M processing, and without subsequent hot working. Still higher properties are obtained after the HIP billets are forged.

REPORT NO: AFML-TR-75-16 AD A 015 831
ACCESS NO: 203,880 August 1975
TITLE: GROWTH OF MULTICOMPONENT COMPOSITES FROM THE MELT
AUTHOR(S): K. Young, E. Dunn, et.al.
CONTRACT NO: F33615-71-C-1374
CONTRACTOR: M.I.T.
PROJECT MONITOR: Capt. Dunco (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An experimental investigation of interface stability during plane front solidification of the two phase α plus θ region of the Al-Cu-Ni system has been conducted. Further experimental work has been conducted on the effects of shape and direction variations on both the binary Al-Du and ternary Al-Cu-Ni eutectic in-situ composites. A theory is given which relates the composition of interdendritic "eutectic" forming during unidirectional solidification to solidification variables. This theory shows that the composition of the solid freezing from the interdendritic liquid is not equal to the eutectic composition but is exactly equivalent to the composition of the alloy which would just grow with a planar front at the same growth rate and temperature gradient.

REPORT NO: AFML-TR-75-24 AD A 013 881
ACCESS NO: 203,736 February 1975
TITLE: ADAPTIVE NONLINEAR SIGNAL PROCESSING FOR CHARACTERIZATION OF ULTRASONIC NDE WAVEFORMS, TASK I: INFERENCE OF FLATBOTTOM HOLE SIZE
AUTHOR(S): A. Mucciardi, R. Shankar, et.al.
CONTRACT NO: F33615-74-C-5122
CONTRACTOR: Adaptronics, Inc.
PROJECT MONITOR: Dr. M. Buckley (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: The overall objective of this first work task was to demonstrate the feasibility of adaptive nonlinear signal processing techniques, from cybernetics, and bionics, applied to characterization of ultrasonic nondestructive testing (UNDT) waveforms for accurate inferences of flat-bottom sizes. Maximum amplitude of the pulse echo time waveform was not found to be a discriminating parameter when the transducer and/or transmission medium was changed.

REPORT NO: AFML-TR-75-30
ACCESS NO: 203,845 April 1975
TITLE: EFFECT OF OMEGA PHASE ON SELECTED PROPERTIES OF BETA III TITANIUM ALLOY
AUTHOR(S): F. Froes, R. Malone, et.al.
CONTRACT NO: F33615-71-C-1266
CONTRACTOR: Colt Industries/Crucible, Inc.
PROJECT MONITOR: R. Geisendorfer, S. Fujishiro (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The heat treatable beta alloys possess an outstanding combination of properties and have shown promise for a number of applications in the aerospace industry. Utilization, however, has been somewhat limited by a low elastic modulus:density ratio. Two approaches to increase the elastic modulus, increasing the proportion of high modulus phases and reducing the mean free path in the low modulus phase, were investigated using a number of thermo-mechanical processing and aging sequences and fine structure analysis. The results show that the elastic modulus can be increased by (1) an increase in the proportion of the high modulus alpha phase, (2) judicious increase in the amount of omega, and (3) an increase in the molybdenum content of the beta phase. There was no increase in modulus with a decrease in the mean free path in the beta material.

REPORT NO: AFML-TR-75-41, Vol. I and II
ACCESS NO: 203,925 September 1975
TITLE: RESEARCH ON DEEP HARDENING TITANIUM ALLOY FOR LARGE AIRFRAME STRUCTURAL MEMBERS
AUTHOR(S): F. Froes, R. Malone, V. Petersen, et.al.
CONTRACT NO: F33615-71-C-1525
CONTRACTOR: Colt Industries/Crucible, Inc.
PROJECT MONITOR: J. Hall, M. Greenfield (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This is the final technical report of a contract to develop a titanium alloy capable of being hardened in section sizes significantly greater than currenly available while retaining adequated toughness and tensile ductility. Work was carried out in three successive phases: Phase I in which the hardening potential at the center of a six-inch section was defined for sixty alloy compositions; Phase II in which the detailed evaluation of tensile properties and fracture toughness data of aged samples led to development of characteristic alloy trend lines for the ten most promising alloys; and finally, Phase III in which three alloys - alloy 334 (10Mo-6Cr-2.5Al), 227 (7Mo-4Cr-2.5Al), and 253 (10Mo-8V-2.5Al) - were scaled up as 500 lb. ingots.

AFML/LL

REPORT NO: AFML-TR-75-43 AD A 015 728
ACCESS NO: 203,885 July 1975
TITLE: EFFECTS OF PURITY AND PROCESSING ON THE EXFOLIATION CORROSION BEHAVIOR OF 7X75 ALUMINUM PLATE
AUTHOR(S): Lt. P. Blau
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Lt. P. Blau (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effect of varying iron and silicon content on the exfoliation corrosion behavior of two 7X75 type wrought aluminum alloys was investigated using the ASTM "EXCO" test. One series of alloy plates was basically the composition of 7475 with total iron and silicon varying in five steps between 0.03 and 0.31 weight percent. The other series contained Zr in place of Cr in the basic composition, and had comparable variation in iron and silicon content. Test results showed that in general, Fe and Si content had no significant effect on exfoliation resistance in either temper or alloy series. Corrosive attack on the TMP coupons was more uniform than on the T651 coupons. Long subsurface cracks were observed in the T651 coupons. Machined sides of TMP coupons showed almost no attack, while those of the T651 coupons pitted. The depth of attack was about 1.5 times greater on the rolled surfaces of the T651 coupons compared to the TMP coupons. End-grain attack depth of T651 coupon sides was three times that of TMP coupon sides.

REPORT NO: AFML-TR-75-50 AD A 015 860
ACCESS NO: 201,790 June 1975
TITLE: LOW-TEMPERATURE LARGE-AREA BRAZING OF TITANIUM STRUCTURES
AUTHOR(S): R. Wells
CONTRACT NO: F33615-73-C-5161
CONTRACTOR: Northrop Corp.
PROJECT MONITOR: G. Metzger (AFML/LLM)
PROJECT NO: 7351
TASK NO: 73510222
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Various brazing filler metals were identified and brazing processes established for producing large-area damage-tolerant laminates of Ti-6Al-4V, Ti-6Al-6V-2Sn, and Ti-3Al-8V-6Cr-4Mo-4Zr for service between 227°K and 422°K. Low melting-temperature filler metals were identified to permit the fabrication of laminates in the STA condition. Brazing filler metals were screened based upon their flow temperature and behavior, lap shear strength, bend deflection, and corrosion resistance. The most attractive brazing filler metals were aluminum brazing sheet 22 and alloys from the Al-Cu-Ag system. The brazing sheet was placed between the lamina and the Al-Cu-Ag alloys were placed alongside the lamina and flowed into the joints. The results of this program indicated that damage tolerant titanium structures can be produced in the STA condition with excellent damage tolerant properties in the crack arrest orientation and with no reduction in properties in the crack divider orientation. Considering properties and producibility, the brazing filler metal 22 is the most attractive system for producing these laminates.

AFML/LL

REPORT NO: AFML-TR-75-52 AD A 015 729
ACCESS NO: 203,844 June 1975
TITLE: EFFECT OF PLASTIC PRESTRAIN ON THE TENSILE STRAIN TO FAILURE OF BERYLLIUM
AUTHOR(S): T. Nicholas
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: T. Nicholas (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Results of tensile tests on specimens of CIP/HIP P-1 beryllium previously prestressed into the plastic range are presented. Two types of prior deformation are considered, a plastic precompression and a plastic pretension followed by plastic compression. Data from tests involving levels of prestress between 40 and 55 ksi show no reduction in the uniaxial tensile strain to failure as a result of prior plastic deformations as high as one percent. An increase in tensile flow stress is observed for the precompressed specimens.

REPORT NO: AFML-TR-75-54
ACCESS NO: 203,822 July 1975
TITLE: INSTRUMENTED IMPACT TESTING USING A HOPKINSON BAR APPARATUS
AUTHOR(S): T. Nicholas
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: T. Nicholas (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A technique for conducting instrumented Charpy impact tests using a Hopkinson bar is presented. Data for three grades of beryllium covering a range in impact velocities from 20 to 200 in/sec. are obtained in the form of load deflection curves from which maximum load, maximum deflection, and total energy are obtained. Results show good agreement with data on identical materials obtained from an instrumented impact test at 54 in/sec. and from a standard Charpy impact machine at 135 in/sec. The advantages and limitations of the Hopkinson bar apparatus are discussed.

REPORT NO: AFML-TR-75-57 AD A 018 635
ACCESS NO: 204,059 August 1975
TITLE: THE EFFECTS OF REST-TIME ON FATIGUE CRACK RETARDATION AND OBSERVATIONS
AUTHOR(S): W. Sharpe, Jr., D. Corbly, A. Grandt, Jr.
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Corbly (AFML/LLN)
PROJ. NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Increasing the rest-time of the specimens had the effect of slightly reducing the crack retardation as measured on the specimen surface. Crack opening loads measured on the specimen surface were found to increase with application of an overload and then decrease to the original value when the specimen was allowed to rest at zero load, while opening loads measured through the sample by the ultrasonic method did not vary significantly with peak loads or rest-times. Varying specimen thickness between 0.64 and 2.54 cm had little effect on surface-measured retardation or opening loads. The relationship between applied load and crack surface displacement as measured by ultrasonics varied significantly with specimen thickness.

REPORT NO: AFML-TR-75-60 AD A 019 750
ACCESS NO: 204,104 June 1975
TITLE: EXPLORATORY DEVELOPMENT OF IMPROVED CUTTING TOOLS FOR TITANIUM
AUTHOR(S): E. Rudy
CONTRACT NO: F33615-71-C-1385
CONTRACTOR: Oregon Graduate Center
PROJECT MONITOR: Dr. R. Ruh
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Substoichoimetric WC-Ni sintered carbide cutting tools, optionally doped with small quantities of selected carbonitrides and carbides for grain size control, show significantly improved resistance to localized crater wear over conventional C-2 and C-3 grade carbides in turning Ti6 Al4V alloy, at about equivalent flank wear resistance. The best performing alloys are those with a dual grain structure of respectively 1 to 2μ and 6 to 10μ tungsten carbide, binder contents between 16 to 9 percent by weight, and carbon deficiencies corresponding closely to the borderline of η-carbide formation. Armor penetration tests with unjacketed projectiles yielded good results with the cast alloys, while tests using cemented carbides were inconclusive.

REPORT NO: AFML-TR-75-84 AD A 020 283
ACCESS NO: 204,112 November 1975
TITLE: CRACK PROPAGATION CHARACTERISTICS IN THREE DEEP HARDENABLE TITANIUM ALLOYS
AUTHOR(S): P. Bania
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: P. Bania (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Three deep-hardenable grade titanium alloys have been evaluated for fatigue crack propagation characteristics. While a slight difference was noted in transverse/longitudinal orientations, no difference was detected from center to edge in 6" diameter forging billets. Stress corrosion cracking resistance was judged to be adequate for the chromium containing alloys and excellent for the chromium free alloy. Fractographic analysis revealed that an apparently brittle phase was contributing to fracture. This phase was indirectly identified as a boride containment.

AFML/LL

REPORT NO: AFML-TR-75-95 AD A 016 473
ACCESS NO: 203,896 July 1975
TITLE: DEFORMATION MODE OF VOID-GROWTH AND COALESCENCE IN THE PROCESS OF DUCTILE FRACTURE
AUTHOR(S): S. Oh, S. Kobayashi
CONTRACT NO: F33615-72-C-1645
CONTRACTOR: University of California
PROJECT MONITOR: V. DePierre (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this investigation was to develop a fracture criterion applicable to the prediction of the occurrence of cracks in metal-working processes. A model for large void growth was proposed, and the deformation mode was calculated by the elastic-plastic finite-element method. The results of the calculation showed the formation of a shear band between large voids. The proposed fracture criterion is that the growth and coalescence of small voids along this shear band is the final process of fracturing. The fracture strain was estimated for a material by applying the McClintock analysis to small void coalescences. The proposed model offers an explanation for some important aspects of experimental observations of ductile fracture.

REPORT NO: AFML-TR-75-100 AD A 019 518
ACCESS NO: 204,092 September 1975
TITLE: FRACTURE TOUGHNESS AND AGING BEHAVIOR OF ALPHA-BETA TITANIUM ALLOYS
AUTHOR(S): H. Margolin, E. Levine, M. Young, et al.
CONTRACT NO: F33615-72-C-1529
CONTRACTOR: Polytechnic Institute of New York
PROJECT MONITOR: Dr. L. Bidwell (AFML/LLM)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Fracture toughness K_Q was studied as a function of microstructure for alloy #2, Ti-5.25 Al-5.5V-0.9Fe-0.5Cu, at a y.s. of 180 Ksi (1241 MN/m^2) and for Ti-6Al-2Sn-4Zr-6Mo at a y.s. of 160 Ksi (1100 MN/m^2), with emphasis on alloy #2. For equiaxed structures K_Q initially decreased with increasing grain size (G.S.) and subsequently increased. Analysis of Widmanstätten plus grain boundary α data separated out the G.S. contribution which was attributed to increased plasticity when the G.S. became significantly large with respect to calculated plastic zone sizes. Experiments were conducted to correlate microstructure and mechanical properties for Ti-6-2--4-4.

REPORT NO: AFML-TR-75-101 AD B 006 928 L
ACCESS NO: 203,886 July 1975
TITLE: CRACK ARREST IN TITANIUM
AUTHOR(S): S. Burns
CONTRACT NO: F33615-74-C-5064
CONTRACTOR: University of Rochester
PROJECT MONITOR: R. Donat (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The propagation of cracks in commercial grade Ti-6Al-4V was investigated by detailed measurements of crack lengths versus time. Critical stress intensity factors during crack propagation were calculated from a fully dynamic mechanics analysis of propagating cracks. It was found that critical stress intensity factors increase with increasing crack velocity. Mechanical and metallurgical characterization of two Ti-6Al-4V alloys were investigated to identify possible sources of fracture toughness.

REPORT NO: AFML-TR-75-105
ACCESS NO: 204,094 June 1975
TITLE: WATER DROP/BOW SHOCK INTERACTIONS
AUTHOR(S): Dr. J. Barber, Dr. E. Grood, H. Taylor, et al.
CONTRACT NO: F33615-73-C-5027
CONTRACTOR: University of Dayton
PROJECT MONITOR: Dr. A. Hopkins (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The interaction of water drops of diameters in the range of 20 to 200μm with reentry vehicle bow shocks was investigated with a microscope/Q-spoiled laser camera system. An analytical study of the droplet/bow shock interaction was undertaken. Calculations showed that droplets above about 20μm in diameter should remain intact and impact the projectile nose tip in the stagnation region. In the stagnation region, droplets of this size should experience little deviation from a straight trajectory. These predictions were confirmed experimentally using the techniques described in this report.

REPORT NO: AFML-TR-75-119 AD A 020 021
ACCESS NO: 204,100 September 1975
TITLE: RESEARCH TOWARD HIGH STRENGTH HIGH TOUGHNESS STEELS
AUTHOR(S): Staff Report
CONTRACT NO: F33615-73-C-5100
CONTRACTOR: University of California at Berkeley
PROJECT MONITOR: W. Griffith (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Several different ways of microstructural control were attempted in maraging type steels in order to achieve a combination of high strength and high toughness. In Section I, the composition, processing, and mechanical properties of Fe-Ni-Ti alloys are described. In Section II, the well-known toughening mechanism, i.e., grain refinement, retained austenite, and the TRIP (transformation induced plasticity) mechanism are incorporated to a 250 grade maraging steel. In Section III we report initial success with an alternate toughening technique: the introduction of a dense mobile dislocation density through rapid phase transformation of a partially maraged structure.

REPORT NO: AFML-TR-75-121 AD A 018 670
ACCESS NO: 204,057 October 1975
TITLE: TWO DIMENSIONAL STRESS INTENSITY FACTOR SOLUTIONS FOR RADIALLY CRACKED RINGS
AUTHOR(S): Capt. A. Grandt
CONTRACT NO: N/A
CONTRACTOR: Internal
PROJECT MONITOR: Capt. A. Grandt (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: A weight function technique is used to obtain mode I stress intensity factor solutions for radially cracked rings loaded with arbitrary crack face pressure. When the crack face pressure is defined as the hoop stress occurring in an unflawed member subjected to complex loading, stress intensity factor calibrations may be obtained by the linear superposition method. This procedure is demonstrated with calculations for rings loaded in compression, for cylinders under internal and external pressure, and for centrifugal stresses induced by rotating the rings. Solutions obtained in this manner agree well with previous results found by other methods. It is suggested that the solution and techniques described here may have further application to other practical problems.

REPORT NO: AFML-TR-75-140 AD A 018 059
ACCESS NO: 204,007 October 1975
TITLE: INFLUENCE OF IRON AND SILICON CONTENT ON THE TENSILE PROPERTIES OF 7X75 AND ZR-MOLDED 7X75 ALUMINUM PLATE
AUTHOR(S): Lt. P. Blau
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Lt. P. Blau (AFML/LLS)
ABSTRACT: This report studied how tensile strength and ductility of 7475-type aluminum plates were affected by Fe and Si content, minor Zr substitutions for Cr, and thermomechanical processing (TMP) versus T651 tempers. In all, twenty combinations of composition and temper were examined. Smooth tensile specimens with 1/4 and 1/2 inch diameters were used. As Fe and Si content decreased, elongation and reduction of area increased in all but the T651 Zr-containing alloys. Purity had little effect on ultimate tensile and yield strength. The Zr-containing alloys were generally stronger than the Cr-containing alloys and had comparable ductility. Compared to the T651 temper, TMP had lower strength and higher ductility. TMP also increased the alloys' sensitivity to the Fe and Si content.

REPORT NO: AFML-TR-75-143 AD A 020 083
ACCESS NO: 204,114 August 1975
TITLE: MICROSTRUCTURE MECHANICAL PROPERTY RELATIONSHIP IN SUPERALLOYS
AUTHOR(S): M. Menon
CONTRACT NO: F33615-75-C-5207
CONTRACTOR: Wright State University
PROJECT MONITOR: W. Reimann (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106 A8
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The primary objectives of this program were to investigate the conditions leading to the abnormal grain growth behavior in Rene´ 95 extrusions, and to study the microstructure of AF115 and the effect of hold time conditions on the low-cycle fatigue behavior of necklace Rene´ 95. A three phase experimental program was designed to accomplish this goal. In the study of grain growth behavior it was found that the material when extruded below the gamma-prime solvus temperature did not undergo secondary recrystallization in a subsequent anneal with a fast heating rate at a higher temperature. However, when a slow heating rate was employed, the extrusions showed significant indications of secondary recrystallization.

REPORT NO: AFML-TR-75-144
ACCESS NO: 204,006 September 1975
TITLE: EXPLORATORY DEVELOPMENT TO STUDY THE LONG-TERM EFFECTS OF RESORBABLE CERAMICS IN PRIMATES
AUTHOR(S): G. Graves, F. Noyes
CONTRACT NO: F33615-72-C-1835
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: Dr. R. Ruh (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of the program was to study the suitability and long-term effect of resorbable ceramic implants as bone gap bridges in Rhesus monkeys. The long-range goal of work of this type is to demonstrate the feasibility of long bone repair in humans using resorbable ceramic implants. The ceramics used as implants were porous calcium aluminates with phosphorous pentoxide additions. Medical examination of the soft tissue surrounding the implants showed no sign of infection or toxic reaction. Medical examination of the major organ showed no visible signs of infection or other untoward reaction. Examination of the implants using a scanning electron microscope revealed that the composition and resulting pore structure did not encourage manualized bone ingrowth. Short-term implant studies have since shown that an increased amount of P_2O_5 (20%) and a pore size of 60 - 80 μm provides the optimum amount of resorption and bone ingrowth.

REPORT NO: AFML-TR-75-168 AD A 020 076
ACCESS NO: 204,099 October 1975
TITLE: MECHANICAL PROPERTIES OF STRUCTURAL GRADES OF BERYLLIUM AT HIGH STRAIN RATES
AUTHOR(S): T. Nicholas
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: T. Nicholas (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An experimental technique is described for obtaining high rate tensile stress strain data on materials with limited ductility. A modified split Hopkinson bar apparatus is used to obtain data on three advanced structural grades of beryllium at strain rates up to 500 sec^{-1}. The data indicate that there is no significant loss in ductility with increasing strain rate in any of the three grades of beryllium. Flow stress is shown to increase linearly with strain rate up to strain rates of 1 - 10 sec^{-1} and then more abruptly at higher rates.

REPORT NO: AFML-TR-75-171 AD A 020 322
ACCESS NO: 204,135 October 1975
TITLE: A TEST METHOD FOR EVALUATION OF METAL POWDERS
AUTHOR(S): N. Birla, V. DePierre
CONTRACT NO: F33615-73-C-5097
CONTRACTOR: University of Cincinnati
PROJECT MONITOR: A. Adair, V. DePierre (AFML/LLM)
PROJECT NO: 7351
TASK NO: 73510815
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: A speedy and economical test method for determining the potential of metal powders to achieve desired mechanical properties after consolidation is described. It consists of encapsulating metal powders in an evacuated metal tube and reducing the outside diameter of the powder-filled tube by swaging to produce a fully consolidated powder bar which provides material for tensile testing. The tensile test results measure the potential of the metal powders. Application of the method to an evaluation of spherical (REP) and angular (H/DH) titanium alloy (Ti-6Al-2Sn-4Zr-6Mo) metal powders demonstrates the procedure can also be utilized to determine processing properties of metal powders. Results show both spherical and angular powders upon complete consolidation furnish tensile properties equivalent to conventional wrought Ti-6246 material. Results also indicate that the hydride powders (1.9% hydrogen) are less apt to be contaminated during processing. The test method is recommended as an excellent tool for determining the potential of metal powders to achieve mechanical properties and for establishing optimum processing parameters for consolidation of metal powders.

ELECTROMAGNETIC MATERIALS DIVISION (AFML/LP)

REPORT NO: AFML-TR-74-223 AD B 001 796 L
ACCESS NO: 203,345 October 1974
TITLE: EXPLORATORY DEVELOPMENT ON THE FEASIBILITY AND RECOMMENDATION FOR NDI OF IR WINDOWS
AUTHOR(S): D. Smith, A. Oaks
CONTRACT NO: F33615-74-C-5125
CONTRACTOR: General Electric Co.
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A survey and evaluation have been conducted of the state-of-the-art in nondestructive inspection (NDI) techniques for potential application for monitoring real-time in situ performance of a solid high energy laser window of an operational system. As a basis for evaluation, the AFWL Airborne Laser Laboratory (ALL) Low Power External Window (LPEW) was chosen for the application. Of the 25 individual techniques evaluated, 6 were found to have promise and one was recommended for consideration when and if a design change is contemplated for the present ALL Automatic Pointing and Tracking (APT) system to accommodate the access requirement.

REPORT NO: AFML-TR-74-240
ACCESS NO: 69,009 December 1974
TITLE: DEVELOPMENT OF CHALCOPYRITE CRYSTALS FOR NONLINEAR OPTICAL APPLICATIONS
AUTHOR(S): R. Begley, et al.
CONTRACT NO: F33615-72-C-2011
CONTRACTOR: Stanford University
PROJECT MONITOR: V. Donlan (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This final report summarizes recent progress in the growth of three chalcopyrite crystals, $CdGeAs_2$, $AgGaSe_2$ and $AgGaS_2$. Recent applications of these crystals to the generation of tunable infrared radiation has been more actively pursued as a result of a number of important requirements for tunable sources. The bulk of this final report treats in detail the theory of nonlinear interactions in solids. The treatment includes a discussion of third and fourth harmonic generation. Recent work in $AgGaSe_2$ for infrared generation by mixing is presented in Appendix III as a reprint. Also included in Appendix IV is a preprint of a paper describing a new model for the calculation of second order nonlinear susceptibilities. The Bond Orbital Model is a physically descriptive model which should prove useful for estimating nonlinear properties of new semiconducting crystal compounds.

REPORT NO: AFML-TR-74-268 AD A 007 852
ACCESS NO: 203,442 November 1974
TITLE: PYROELECTRIC FILM/LIQUID CRYSTAL DETECTOR FOR 10.6 μm REGION
AUTHOR(S): J. Margerum, M. Little, and P. Braatz
CONTRACT NO: F33615-73-C-5129
CONTRACTOR: Hughes Research Laboratories
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: The development of a new type of large area infrared detector cell with visible light readout is studied in which a liquid crystal layer is electro-optically activated by a pyroelectric film. These studies include the evaluation of pyroelectric films and their poling techniques, the evaluation of liquid crystals for use with pyroelectric currents, analysis of thermal time constants in various cell layers, evaluation of signals obtained with test cells, and the development of prototype detectors. Polyvinylidene fluoride (PVF_2) is selected as the best large area pyroelectric material available and responsivities as high as 5.5 μ A/W are obtained with freely suspended poled films.

REPORT NO: AFML-TR-74-274
ACCESS NO: 201,818 February 1975
TITLE: ROOM TEMPERATURE INJECTION LUMINESCENCE IN II-VI SEMICONDUCTORS
AUTHOR(S): N. Low, L. Bradfield
CONTRACT NO: F33615-72-C-1466
CONTRACTOR: Bowmar Research and Development Division, Canada
PROJECT MONITOR: Dr. P. Heminger (AFML/LPO)
PROJECT NO: 7367
TASK NO: 736703
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: In a continuation of previous investigations of injection luminescent device structures based on single crystal ZnS, several theoretical models are discussed which may account for the blue electroluminescence emission from nominally undoped or compensated ZnS diodes. It was postulated that hot carrier injection from In-ZnS Schottsky barriers might be a likely process as needle-like voids filled with indium were observed in the ZnS crystal. An alternative objective for the investigations has involved experimental work on polycrystalline II-VI compounds, subsequently extended to polycrystalline III-V compound materials, and the evaluation of the potential of these materials in light-emitting device applications. Other experimental studies included such studies as comprehensive evaluation program on the morphological features of the ZnSe powders and the microstructure of the hot-pressed II-VI and III-V compound powdered compact.

REPORT NO: AFML-TR-74-277 AD A 011 779
ACCESS NO: 203,569 January 1975
TITLE: MAGNETIC RELAXATION EFFECTS IN $PrCo_5$ AND $Sm_xNd_{1-x}Co_5$ INDUCED BY HYDROGEN AND DEUTERIUM
AUTHOR(S): I. Maartense
CONTRACT NO: F33615-73-C-5060
CONTRACTOR: University of Manitoba
PROJECT MONITOR: D. Evans (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Measurements of the ac susceptibility of $PrCo_5$ powder parallel to its c-axis show the existence of two relaxation processes which are present in samples exposed to hydrogen or deuterium but not in degassed samples. The two relaxations have time constants of 10 sec. at 165°K and at 200°K and are described by effective activation energies of 0.37 eV and 0.51 eV, respectively. $Sm_xNd_{1-x}Co_x$ crystals treated with hydrogen show a magnetic relaxation equivalent to the higher energy process in $PrCo_5$; between -20°C and 50°C, a strong Barkhausen effect dominates the magnetic behavior.

AFML/LP

REPORT NO: AFML-TR-74-281 AD A 008 782
ACCESS NO: 203,502 February 1975
TITLE: PERFECTION OF CaLaSOAP:Nd LASER MATERIAL
AUTHOR(S): R. Hopkins, et al.
CONTRACT NO: F33615-74-C-5023
CONTRACTOR: Westinghouse Electric Corp.
PROJECT MONITOR: V. Donlan (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Calcium lanthanum silicate oxyapatite (CaLaSOAP) is an intermediate gain laser material developed for high energy storage and high average power Q-switching applications. The objective of this program was to increase the bulk and surface laser damage resistance of CaLaSOAP crystals and the yield of laser quality boules so that the full potential of the material could be realized in Q-switched laser ranger systems. Crack-free crystals up to 0.7 in. diameter were grown and fabricated into optically homogeneous 0.375 diameter laser rods free from inclusions detectable by laser light scattering. The key to this result was the reduction in thermal gradient in the growth system, use of O_2/N_2 furnace atmospheres, and the automatic control of crystal diameter to within $\pm$ 1 to 2%. Boule yield was nearly tripled to 77% compared to precontract results.

REPORT NO: AFML-TR-75-10 AD A 018 128
ACCESS NO: 204,035 July 1975
TITLE: EXPERIMENTAL HYSTERETIC LOSS FOR A SERIES OF SUPERCONDUCTING FILAMENTARY NbTi WIRES AND A FIELD DEPENDENT CRITICAL STATE MODEL
AUTHOR(S): M. Ohmer, J. Wollan, L. Lawson
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. M. Ohmer (AFML/LPE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report summarizes the Air Force superconducting wire applications, the goals of future superconducting materials development, the state-of-the-art theories of ac loss in superconductors, and the results of hysteretic loss measurements on a series of niobium titanium multifilamentary wires. Expressions were developed for magnetization and hysteretic loss for half cycle and full cycle for rod geometries for a critical state model with critical current inversely proportional to field. The loss expressions of various models are compared to experimental loss. Universal loss curves constructed from experimental loss curves by appropriate normalization are obtained and used to predict loss accurately. The temperature dependence of the critical current for niobium titanium, niobium (sub 3)-tin, and niobium carbonitride was obtained from magnetization curves through the critical state model.

REPORT NO: AFML-TR-75-15 AD B 004 218 L
ACCESS NO: 203,566 February 1975
TITLE: SOME EFFECTS OF ENVIRONMENTAL FACTORS ON THE PERFORMANCE OF COATINGS FOR HIGH POWER IN LASERS
AUTHOR(S): G. Johnston, D. Walsh
CONTRACT NO: F33615-74-C-5001
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: C. Strecker (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: A series of tests has been performed to evaluate the effect of environemental factors on the optical performance of antireflective coated ZnSe. The primary objective of the tests was to determine the effect of cloth abrasion, sand erosion, and temperature-humidity cycling on the reflectance, scattering, surface topography, and absorption coefficient of the coated specimens. A secondary objective was to determine the effects of environmental factors on the resistance to damage by medium power (1 KW) CO_2 laser irradiation. After post-test characterization of the separate effects, selected combinations of the tests were evaluated. In general the sensitivity of the 10.6μm optical performance of the coatings to environmental factors was less than had been anticipated. Measurable increases in absorption coefficient and specular reflection required grossly visible mechanical damage.

REPORT NO: AFML-TR-75-18
ACCESS NO: 203,173 February 1975
TITLE: PROTECTIVE-ANTIREFLECTIVE THIN FILMS FOR POLYCRYSTALLINE ZINC SELENIDE AND ALKALI HALIDE LASER WINDOWS
AUTHOR(S): M. Braunstein, J. Rudisill
CONTRACT NO: F33615-73-C-5044
CONTRACTOR: Hughes Research Laboratories
PROJECT MONITOR: Dr. M. Ohmer (AFML/LPO)
DIST. STATEMENT: U. S. Govt. Agencies Only
ABSTRACT: The development of surface finishing and coating technology at 10.6μm for polycrystalline zinc selenide laser windows is presented. Optical evaluation of the coated windows shows that the 10.6μm absorption, reflection, and scattering can be held to less than 0.1% per surface. Surface finishing procedures, theoretical coating designs, and experimental results for BaF_2/ZnS, ThF_4/ZnS, and $ThF_4/ZnSe$ antireflection coating designs are presented. Efforts devoted to ZnSe demonstrate the scalability of the processes used for polishing and coating of small discs to fabrication of large diameter laser windows. Surface finishing procedures, theoretical coating designs, and experimental results for $ZnSe/ThF_4$ and As_2S_3/ThF_4 antireflection coatings for HRL RAP grown KCl are presented.

REPORT NO: AFML-TR-75-21 AD A 008 783
ACCESS NO: 203,497 March 1975
TITLE: EXPLORATORY DEVELOPMENT OF TRANSPARENT CONDUCTOR MATERIALS
AUTHOR(S): G. Haacke
CONTRACT NO: F33615-74-C-5021
CONTRACTOR: American Cyanamid Co.
PROJECT MONITOR: R. Van Vliet (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The development of electrically conductive cadmium stannate coatings with high visible transparency and high infrared reflectivity has been pursued. Efforts concentrated on the investigation of different deposition technologies, film doping, coating of various substrate materials, and film testing.

REPORT NO: AFML-TR-75-23 AD A 014 360
ACCESS NO: 203,798 February 1975
TITLE: AC LOSS AS A FUNCTION OF CURRENT AND EXTERNAL MAGNETIC FIELD IN COMMERCIAL NbTi SUPERCONDUCTORS
AUTHOR(S): D. Ho, M. Robinson, V. Srivastava, R. Stevenson
CONTRACT NO: F33615-73-C-5163
CONTRACTOR: Canada Superconductor and Cryogenics Co., Ltd.
PROJECT MONITOR: Dr. M. Ohmer (AFML/LPO)
PROJECT NO: 62102F
TASK NO: 73710324
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Alternating current loss as a function of current and external magnetic field in commercial NbTi superconductors has been measured with an electronic wattmeter. The loss varies as the current cubed, and the increase of loss with the external magnetic field could be related to the decrease of the d.c. short sample current with field.

REPORT NO: AFML-TR-75-27 AD A 014 362
ACCESS NO: 203,805 April 1975
TITLE: CHEMICAL VAPOR DEPOSITION OF MULTISPECTRAL DOMES
AUTHOR(S): B. di Benedetto, J. Pappis
CONTRACT NO: F33615-73-C-1073
CONTRACTOR: Raytheon Co.
PROJECT MONITOR: D. Fischer (AFML/LPO)
PROJECT NO: 7371
TASK NO: 737101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The significance of this development program to the Air Force is the demonstrated capability of fabricating chemical vapor deposited zinc sulfide windows and hemispherical domes. A zinc sulfide plate, 10 X 10 X 5/8 in., and a 9-inch hemispherical dome were fabricated and optically polished to specification. As a result of this work the optical and structural properties of zinc sulfide were significantly improved. It was also demonstrated that it is possible using the CVD process to deposit multiple domes per run. Significant progress was also made in the development of zinc sulfo-selenide solid solutions. Improvements were realized in the optical and structural properties of these deposits.

REPORT NO: AFML-TR-75-28
ACCESS NO: 201,819 April 1975
TITLE: THERMAL, ELECTRICAL AND PHYSICAL PROPERTY MEASUREMENTS OF LASER WINDOW MATERIALS
AUTHOR(S): J. Wurst, T. Graham
CONTRACT NO: F33615-72-C-1257
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: C. Strecker (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Various II-VI and alkali halide compounds were subjected to a comprehensive evaluation to determine their relative effectiveness in a CO_2 laser window application. Primary emphasis was directed towards mechanical properties and more than 600 flexual test specimens were evaluated in the course of this 20 month effort. Evaluation of the alkali halides KCl, KBr, NaCl, and their alloys was initiated midway through the program. KCl alloyed with KBr, RbCl or Eu^{+2} and hot forged to produce a fine-grained microstructure was the most promising of the alkali halides. Bests results were obtained with alloys grown as single crystals by Harshaw and subsequently hot forged by Honeywell Corporation.

REPORT NO: AFML-TR-75-34 AD A 019 452
ACCESS NO: 204,093 October 1975
TITLE: DEVELOPMENT OF LIQUID CRYSTAL SYSTEMS FOR AIR FORCE DISPLAY APPLICATIONS
AUTHOR(S): R. Rondeau, L. Knaak, H. Rosenberg, R. Steppel
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A series of 4 (4')--alkoxyformyloxy-4' (4)-alkylazoxybenzenes were prepared. The transition temperatures have been determined and the applicability of the nuclear magnetic resonance spectral shift reagent Eu $(fod)_3$ to determine the mole percent of structural isomeric mixtures is demonstrated. A survey has been made of reported nematic-isotropic transition temperatures of nematic liquid crystals having a particular structure.

REPORT NO: AFML-TR-75-49 AD A 014 809
ACCESS NO: 203,821 May 1975
TITLE: DEVELOPMENT OF GALLIUM ARSENIDE FOR INFRARED WINDOWS
AUTHOR(S): H. Hafner, G. Cronin
CONTRACT NO: F33615-74-C-1066
CONTRACTOR: Texas Instruments Incorporated
PROJECT MONITOR: D. Fischer (AFML/LPO)
PROJECT NO: 7371
TASK NO: 737101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes methods for preparing high quality infrared transmitting gallium arsenide. The work is broadly divided into categories describing doping studies, vertical pulling techniques, liquid encapsulation, growth methods, horizontal Bridgman and gradient freeze techniques, boat materials, and measurement results. In addition to infrared transmission curves, data are also presented which describe other physical parameters such as Knoop hardness and refractive index.

REPORT NO: AFML-TR-75-66 AD A 013 878
ACCESS NO: 203,787 May 1975
TITLE: GROWTH OF DOPED AND UNDOPED SINGLE CRYSTAL LASER MATERIALS IN THE SYSTEM $(MF_2)_x \cdot (YF_3)_{1-x}$
AUTHOR(S): Dr. J. Balascio
CONTRACT NO: F33615-73-C-5058
CONTRACTOR: Isomet Corporation
PROJECT MONITOR: D. Fischer (AFML/LPO)
PROJECT NO: 7371
TASK NO: 737101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Laser host materials were grown in the CaF_2-YF_3 and BaF_2-YF_3 binaries. Two compositions in the former binary were found to be capable of producing single crystals: $9CaF_2 \cdot YF_3$ and $CaF_2 \cdot 2 \cdot 6YF_3$. The former possessed a fluorite structure and the latter was indexed on a hexagonal unit cell. Trivalent and divalent rare earth-doped single crystals of these compositions were successfully grown. The necessary phase equilibria is presented and discussed.

AFML/LP

REPORT NO: AFML-TR-75-68
ACCESS NO: 203,682 March 1975
TITLE: CHEMICAL VAPOR DEPOSITION OF CADMIUM TELLURIDE
CONTRACT NO: F33615-73-C-5167
CONTRACTOR: Raytheon Research Division
PROJECT MONITOR: Dr. P. Hemenger (AFML/LPO)
PROJECT NO: 2421
TASK NO: 0002
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Chemical vapor deposition techniques have been used to successfully deposit polycrystalline CdTe. The following two reactions were used to obtain theoretically dense material: $Cd(v) + Te(v) \rightarrow CdTe(s)$; $Cd(v) + H_2Te(v) \rightarrow CdTe(s) + H_2(v)$. Typical deposition temperatures ranged between 600° and 700°C, pressures varied from 10 to 40 torr, and the Cd(v)/Te(v) molar input ratios were between 1.0 and 1.5. The major problem encountered with the CdTe was the formation of physical voids in the material during the deposition process. Progress was made to limit the formation of these voids in the latter stages of the contract. The in-line transmittance of the as-deposited CdTe approached the theoretical limit of 66% at 10.6μm. Typical material was p-type with resistivities ranging up to 10^7 ohm-cm.

REPORT NO: AFML-TR-75-73 AD B 007 238 L
ACCESS NO: 203,898 May 1975
TITLE: FLUORIDE WINDOW MATERIALS FOR USE AS LASER WINDOWS IN THE 2 TO 6μm SPECTRAL REGION
AUTHOR(S): H. Winston, R. Pastor, R. Turk, et al.
CONTRACT NO: F33615-73-C-5075
CONTRACTOR: Hughes Research Labs
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: U.S.Govt. Agencies Only
ABSTRACT: Exploratory development of alkaline earth fluorides for application as high-power laser windows in the 2 to 6μm spectral region was conducted. Designs for wideband antireflection coatings to accommodate the multiline outputs of chemical lasers are presented, along with the results of preliminary experiments on depositing appropriate layers to meet design requirements. Infrared and ultraviolet spectra of window blanks show mainly the intrinsic absorption cutoffs of the materials; some impurity absorption is visible in long-path IR spectra. Changes in attenuated total reflections (ATR) spectra with surface treatment can be observed. RAP crystal growth and subsequent press forging can be extended to provide CaF_2 and SrF2 window blanks of any required size.

REPORT NO: AFML-TR-75-79 AD B 008 167 L
ACCESS NO: 204,097 September 1975
TITLE: PROCEEDINGS OF THE FOURTH ANNUAL CONFERENCE ON INFRARED LASER WINDOW
AUTHOR(S): C.R. Andrews, C. Strecker
CONTRACT NO: F33615-75-C-5011
CONTRACTOR: University of Dayton
PROJECT MONITOR: C. Strecker (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The fourth Conference on Infrared Laser Window Materials was sponsored by the Advanced Research Projects Agency and held in Tucson, Arizona on November 18, 19, and 20, 1974. In the three years since the initiation of laser window programs, there has been a continual evolution and advancement in the applied and exploratory research and development of laser window materials. Within the past year, laser window design and hardware productions have been undertaken and completed. Numerous achievements in fabrication and characterization of laser window materials were treated.

REPORT NO: AFML-TR-75-87 AD A 013 069
ACCESS NO: 203,699 April 1975
TITLE: MATERIALS AND TECHNOLOGY FOR NEW INFORMATION DISPLAYS
AUTHOR(S): P. Hemenger
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. P. Hemenger (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The current status of electroluminescent materials and devices is reviewed. The limitations of the presently important materials GaP (gallium-phosphide) and GaAsP (gallium-arsenide-phosphide) are discussed, followed by a survey of candidate materials for future display systems. In particular, the potential of the II-VI semiconductors is presented along with some recent experimental results.

REPORT NO: AFML-TR-75-89 AD A 011 748
ACCESS NO: 203,626 April 1975
TITLE: ZINC ION IMPLANTATION OF SULFUR-DOPED GALLIUM PHOSPHIDE
AUTHOR(S): P. Hemenger, B. Dobbs
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. P. Hemenger (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Sulfur-doped GaP has been implanted with 250-keV Zn ions to a total dose of 10^{16} cm^{-2} and then annealed at 900°C. Hall data obtained with the van der Pauw configuration indicate type conversion in a surface layer that has a thickness estimated from diffusion data and electrical transport properties, on the order of 10μm. For large implant doses followed by annealing, the diffusion of Zn in GaP plays a significant role in the final location of the implanted ions.

REPORT NO: AFML-TR-75-91
ACCESS NO: 204,098 August 1975
TITLE: CHEMICAL VAPOR DEPOSITION OF CHALCOGENIDE SEMICONDUCTORS
AUTHOR(S): H. K. Bowen, J. Vander Sande
CONTRACT NO: F33615-73-C-5166
CONTRACTOR: M.I.T.
PROJECT MONITOR: Dr. P. Hemenger (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Polycrystalline CdTe was prepared by vapor deposition rates of 0.1-0.01 mm/hr at temperatures between 725-785°C. Columnar grains and micron size pores were found in all samples. Electrical property measurements and x-ray texture studies were made. Transmission electron microscopy elucidated the nature of precipitates and voids (50-100 Å) in the as grown material and material from other sources. Scattering theory calculations indicate orders of magnitude agreement with the observed absorption coefficients at 10.6μm. A new absorption measuring technique was developed capable of determining accurately on small samples. The thermal shift in the fundamental absorption edge due to infrared absorption (10.6μm) was used. Both the theory and measurement system were defined.

AFML/LP

REPORT NO: AFML-TR-75-104
ACCESS NO: 203,994 September 1975
TITLE: HALIDE MATERIAL PROCESSING FOR HIGH-POWER, INFRARED LASER WINDOWS
AUTHOR(S): W. Harrison
CONTRACT NO: F33615-72-C-2019
CONTRACTOR: Honeywell, Inc.
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report describes the complete process which was developed for strengthening and characterizing four different single component alkali halides as well as many alloyed and doped halide materials. Hot forged, recrystallized alloyed and doped material, in general, had about the same optical properties as the single crystal material; however, residual stress in the recrystallized material was relatively high and strongly dependent upon the crystal orientation of the forged crystal. It was shown that large recrystallized halide laser windows can be fabricated which have greater than 4000 psi yield strengths with an optical absorption coefficient of 0.6×10^{-3}/cm, optical uniformity of $\lambda/80$ at 10.6μm, and bulk optical scatter of less than 1×10^{-5}/cm.

REPORT NO: AFML-TR-75-142 AD A 018 682
ACCESS NO: 204,037 September 1975
TITLE: HARDENED CVD ZINC SELENIDE FOR FLIR WINDOWS
AUTHOR(S): R. Donadio, A. Swanson, J. Pappis
CONTRACT NO: F33615-74-C-5145
CONTRACTOR: Raytheon Co.
PROJECT MONITOR: Dr. G. Kuhl, D. Fischer (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The significance of this exploratory development program to the Air Force is the demonstration that the CVD process can be used to increase the hardness of optical materials such as zinc selenide and sulfide by the use of dopants such as aluminum and silicon. Increases in Knoop hardness of 50 to 100 percent were realized, although some degradation in optical properties was noted, particularly at visible wavelengths. It was also demonstrated that the CVD process can be used to deposit a thin adhering layer of zinc sulfide or hardened sulfide or selenide to a polished zinc selenide substrate. Finally, it was shown that an elemental CVD process is a feasible method of producing lower cost ZnSe for Flir window applications. Transmittances close to the theoretical limit were achieved and the goal of achieving a cost of $5,000 for 10X10X10.62 in. unpolished plate can be met in production.

MANUFACTURING TECHNOLOGY DIVISION (AFML/LT)

REPORT NO: AFML-TR-73-198 AD 919 288 L
ACCESS NO: 67,738 July 1973
TITLE: PLANETARY BALL SWAGING OF WELDED TITANIUM ALLOY TUBING
AUTHOR(S): R. Huber, *et al.*
CONTRACT NO: F33615-70-C-1279
CONTRACTOR: Nuclear Metals
PROJECT MONITOR: T. Felker (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agnecies Only
ABSTRACT: The objective of this program was to provide economic and versatile methods for the production of titanium alloy tubing for advanced aircraft components such as hydraulic systems. Optimum sequences were established for processing welded tubing of diverse sizes and compositions with the planetary ball swager so that the final welded and worked tubing was at least equivalent in properties and attributes to seamless tubing for aircraft application.

REPORT NO: AFML-TR-74-200
ACCESS NO: 203,995 May 1975
TITLE: COMPLEMENTARY BIPOLAR TRANSISTOR STRUCTURES
AUTHOR(S): F. Poblenz, F. Malone, W. Giolma
CONTRACT NO: F33615-71-C-1944
CONTRACTOR: Texas Instruments Incorporated
PROJECT MONITOR: E. Miller (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this contract was to establish advanced process procedures for manufacturing high-yield, low-cost, dielectrically isolated n-p-n and p-n-p transistors and other electronic circuitry on a single-monolithic semiconductor chip. The development of the two processes (high and low gain) was established and confirmed by the test results on the SN39561 complementary bipolar transistor structures. The special test structures of the X-727 were also used to confirm the established process and then to maintain control over the process. The SN39561 met and, in some instances, exceeded the specifications established for this program. Phase II demonstrated that acceptable production processes had been established in Phase I by successfully manufacturing a dual voltage regulator and a low power operational amplifier.

REPORT NO: AFML-TR-74-202 AD B 001 110 L
ACCESS NO: 203,286 October 1974
TITLE: PHASE SHIFTER MANUFACTURING METHODS
AUTHOR(S): R. May, D. Lewis
CONTRACT NO: F33615-73-C-5160
CONTRACTOR: Hughes Aircraft Co.
PROJECT MONITOR: H. Trinkle (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: It is concluded from the results of the Phase Shifter Manufacturing Methods Program that low-cost production of the Hughes PIN diode phasor is practicable. The program involved six steps; (1) configuration of a phasor suitable for large quantity production; (2) analysis of available methods for fabrication of each phasor component and selection of the methods best suited for large quantity production; (3) experimental investigation of practical assembly techniques; (4) establishment of a driver module design based on the use of special-purpose integrated circuit chips to drive multiple phasors; (5) definition of an automatic assembly line utilizing proved techniques; and (6) formulation of cost estimates for large scale production of both the phasor and the array logic/driver circuits.

REPORT NO: AFML-TR-74-216
ACCESS NO: 203,375 January 1975
TITLE: MANUFACTURING METHODS FOR SPINEL FERRITES FOR USE IN MICROWAVE TUBES
AUTHOR(S): S. Besse, et al.
CONTRACT NO: F33615-71-C-1947
CONTRACTOR: Raytheon Company
PROJECT MONITOR: J. Meulemans (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The technology has been developed and demonstrated for incorporating high Curie temperature lithium spinel ferrites in microwave tubes. Manufacturing methods have been established for a 50-tube per month capacity for each process involved in producing ferrite assemblies for tube use. Protective encapsulation of spinel ferrites by arc-plasma deposition of a 0.003-0.004 in. coating of a mixture of MgO and $MgAl_2O_4$ permitted spinel ferrites to survive high temperature brazing and tube bakeout processing of 450°C without degradation of the dielectric loss. Successful multiple-layered sputter metalization and Ag-Cu eutectic brazing to a copper waffled substrate was accomplished. The development and demonstration of the technology of incorporating spinel ferrites in microwave tubes, when taken in conjunction with the prior demonstration for garnet ferrites, shows the great flexibility that now exists in the selection of ferrites for diverse microwave tube applications.

REPORT NO: AFML-TR-74-228
ACCESS NO: 203,884 January 1975
TITLE: PLATED WIRE MASS MEMORY ARRAY MANUFACTURING METHODS
AUTHOR(S): R. White, J. Casement
CONTRACT NO: F33615-73-C-5002
CONTRACTOR: Sperry Univac
PROJECT MONITOR: J. Garrett (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this project is to establish manufacturing processes and techniques to reduce the cost of plated wire memory arrays for use in plated wire random access mass memory subsystems. Manufacturing processes have been developed for fabricating metal tunnel structures and for providing suitable insulation and adhesion of the metal tunnel structure assembly. Cost improvements have also been achieved through improved packaging of the memory plane and hybrid circuits on the memory plane. A partially populated unit based on these techniques has been constructed and tested successfully. This technology is now ready for system implementation as a ruggedized, medium speed, mass memory system.

REPORT NO: AFML-TR-74-239
ACCESS NO: 203,449 October 1974
TITLE: MANUFACTURING METHODS FOR 30mm DEPLETED URANIUM PENETRATORS
AUTHOR(S): G. Gegel, D. Stellrecht, A. Hoffmanner
CONTRACT NO: F33615-74-C-5109
CONTRACTOR: Battelle Memorial Columbus Labs
PROJECT MONITOR: S. Inouye (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this program was to identify and demonstrate a metal working and a casting process offering the greatest potentials for low cost manufacturing of depleted-uranium alloy penetrators from the two alloys: U-0.75 percent Ti and U-0.75 percent Quad. This objective was achieved in two phases: Phase I - Cost Analyses to justify the selected processes and Phase II - Experimental Work to develop and demonstrate the selected processes for process verification and revision of the original cost analyses.

REPORT NO: AFML-TR-74-244
ACCESS NO: 203,455 January 1975
TITLE: MANUFACTURING METHODS FOR LOW EMISSION GRID COATINGS FOR BARIUM ACTIVATED CATHODE VACUUM TUBES
AUTHOR(S): W. Sain, W. Stuart
CONTRACT NO: F33615-72-C-1328
CONTRACTOR: Varian Associates
PROJECT MONITOR: J. Meulemans (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The methods, techniques, processes, and special equipment necessary for manufacturing electron tube grids with special emission-suppressing coatings were investigated and a pilot production capability was established. The coatings contained carbon and titanium and were applied to the grids in a glow discharge (ion plating) from gaseous carbon and titanium precursor. The grid coating strongly suppresses thermionic electron emission and secondary emission from cathode evaporants deposited on the grid and is compatible with BaSr oxide and tungsten dispenser cathodes. Environmental tests and 1000-hour life tests were performed on tetrodes with the coated grids and both oxide and dispenser cathodes. Primary grid emission (measured at 850°C) and secondary grid emission remained low throughout the 1000-hour life tests in the oxide-cathode and dispenser cathode tetrodes. There was no abnormal degradation in the cathode emission of the oxide; cathode tetrodes rose during life testing; after 1000 hours, the useful cathode emission density exceeded 5 amperes per square centimeter.

REPORT NO: AFML-TR-74-246
ACCESS NO: 200,988 January 1975
TITLE: NOTCHING MACHINE MANUFACTURING METHODS
AUTHOR(S): H. Johannesson
CONTRACT NO: F33615-72-C-1653
CONTRACTOR: New Hampshire Ball Bearings
PROJECT MONITOR: W. Harris (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The project objective was directed at performing the notch grinding operation of full complement bearings more efficiently and to obtain a higher level of quality relative to notch height relationship to the bottom of the ball groove. The work program involved the design and fabrication of a universal work holding fixture for notch grinding both inners and outers. The fixture design included the interfacing of an electronic in-process gaging system that determines and controls the stock removal during the grinding operation to insure that the

proper notch height is achieved. Conversion elements were purchased to alter a Bryant B Racegrinder to a Bryant B Boregrinder. The conversion resulted in providing the necessary reciprocal grinding action instead of the plunge grind action associated with a Racegrinder. This, the final report, reviews the activities from 15 March 1972 through 30 September 1974 relating to: 1) the work holding fixture; 2) the electronic In-Process Gaging System; 3) the Solid State Controller; 4) the grinding results achieved relative to efficiencies and quality.

REPORT NO: AFML-TR-74-275
ACCESS NO: 201,540 March 1975
TITLE: MANUFACTURING METHODS FOR ENGINE BLADE REPAIR
AUTHOR(S): D. Rutz
CONTRACT NO: F33615-72-C-1178
CONTRACTOR: Pratt & Whitney Aircraft
PROJECT MONITOR: Lt. J. Hager (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Large-size titanium material compressor blades are utilized in the entry stages of modern turbofan engines. These blades incur leading edge damage from objects drawn into the engine inlet. An investigative engineering program was conducted to determine cost-effective procedures for repair of fan blades made from Ti-8Al-1Mo-1V and Ti-6Al-4V. Procedures, tooling, and welding techniques were established for the use of welded-in repair segments in place of specific damaged areas on the blade leading edge. Both steady-state and pulsed-current plasma arc welds are recommended as cost-effective methods for segment installation. The repair technology, successfully demonstrated by a subcontractor and the prime contractor, is applicable to approximately 90% of all foreign-object damage on the leading edge of the subject blades. Metallurgical laboratory fatigue tests of repaired blades were successful, and engine testing is projected.

REPORT NO: AFML-TR-75-4, Vol. I, II
ACCESS NO: 203,727 June 1975
TITLE: MANUFACTURING METHODS PROGRAM, IMPATT DIODES
AUTHOR(S): T. Midford, E. Benko, J. Benton
CONTRACT NO: F33615-72-C-1837
CONTRACTOR: Hughes Aircraft Co.
PROJECT MONITOR: Capt. Anderson (AFML/LTE)
PROJECT NO: 601-2
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The primary objectives of this program were to establish manufacturing methods to assure reproducible, high yield, and low cost production of IMPATT diodes for use at microwave and millimeter wave frequencies. In order to achieve the program objectives, the program was divided into five phases. A yield and cost analysis indicated a significant improvement in all manufacturing yields and a resulting factor of ten reduction in the manufacturing cost of Ka-band diodes.

REPORT NO: AFML-TR-75-5
ACCESS NO: 202,196 July 1975
TITLE: HOT ISOSTATIC PRESSING OF Ti-6Al-4V POWDER FORGING PREFORMS
AUTHOR(S): R. Peebles
CONTRACT NO: F33615-72-C-1449
CONTRACTOR: General Electric Co.
PROJECT MONITOR: L. Clark (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: This report was concerned with the selection of one type of Ti-6Al-4V powder from four for the production of hot isostatically pressed (HIP) shaped preforms for subsequent forging to a jet engine disk configuration, and comparing the resulting properties to those of an As-HIP disk, and conventionally wrought material. The selection involved testing for powder characteristics, preferred parameters of 13 HIP parametric variations. The final properties were determined for three conditions: As-HIP; alpha plus beta forging, and conventional beta forging of shaped HIP powder preforms. Final property evaluation included room temperature and 600°F tensile properties, Charpy impact, notch-time-fracture, fracture toughness, high cycle fatigue (smooth and notched), low cycle fatigue, creep, stress rupture, crack growth rate, and metallography.

REPORT NO: AFML-TR-75-6
ACCESS NO: 200,652 December 1974
TITLE: EFFECT OF BEARING DEFECTS
AUTHOR(S): C. Beecher
CONTRACT NO: F33615-72-C-1243
CONTRACTOR: MPB Corp.
PROJECT MONITOR: W. Harris (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This program determined the relationship between selected raceway surface defects and performance and life of miniature ball bearings. Nine defect types were tested at various levels: Comet-Tail, Dig-Nick, Dirt Brinell, Grind-Skip Lines, Inpingement, Orange Peel, Pit, Scratch and "Liney" Finish. Bearing selected was 5/16 OD x 1/8 ID in tolerance grades ABEC1, ABEC 3, ABEC 7P. Performance tests included stating torque, low speed running torque, and vibration. Conclusions are that performance characteristics were influenced to a greater degree than were bearing life times. A specification for defect limitation is presented based on performance and life test evaluation.

REPORT NO: AFML-TR-75-12 AD A 014 364
ACCESS NO: 203,799 March 1975
TITLE: EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS
AUTHOR(S): D. Heinz, M. Elliott, R. Henry, F. Stearns
CONTRACT NO: F33615-73-C-5017
CONTRACTOR: Rockwell International Corp.
PROJECT MONITOR: H. Garrett (AFML/LTE)
PROJECT NO: 7371
TASK NO: 737103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objectives of this program were to develop bubble domain materials which perform in a military environment and meet device goals of a bit density of 1M bit/in^2, a data rate of 1 MHz and an operating temperature range of -25 to 75°C. All of these program objectives have substantially been met. For this program, the military environment was considered to consist of extremes of temperature, dynamic mechanical stress and radiation. Bubble device operation over the temperature range of -25 to 75°C was addressed in the design of garnet compositions. The effects of shock and vibration were explored on bubble domain garnet films and results were obtained that revealed the absence of potentially deleterious magnetomechanical effects. Several studies were carried out including (1) a correlation of wall mobility with FMR parameters, (2) the determination of the exchange constant for substituted garnet compositions, (3) an investigation of the incorporation of flux ions in bubble films grown by LPE, (4) an analysis of the influence of composition on bubble material properties, and (5) growth and characterization of gallium- and germanium-substituted garnet compositions.

AFML/LT

REPORT NO: AFML-TR-75-29 AD B 006 811 L
ACCESS NO: 203,853 January 1975
TITLE: LOW COST BORON FILAMENT
AUTHOR(S): H. DeBolt, V. Krukonis
CONTRACT NO: F33615-74-C-5136
CONTRACTOR: Avco Systems Div.
PROJECT MONITOR: D. Starks (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This program was aimed at circumventing the effects of the crack tip in boron filaments at high speed boosts, or, if not possible to do so, at determining the highest speed boost which could be achieved while maintaining an average filament strength of 400 ksi. The objective of speed boost was to reduce boron filament costs by increasing the production rate. The upper limit of VHF speed boosting was studied as a function of BCl_3/H_2 ratio and gas flow for 4.0-amd 5.6-mil filament production. It was found that a greater speed boost was permissible for 5.6-mil production than for 4.0-mil while maintaining average strengths at 400 ksi or greater. The quantitative results were that with the use of VHF-augmentation 4-mil boron production rate could be increased 30% and 5.6-mil filament could be increased by 50% before the crack tip flaw level reduced the strength below 400 ksi.

REPORT NO: AFML-TR-75-36
ACCESS NO: 201,112 April 1975
TITLE: MANUFACTURING METHODS FOR BBB FIBER
AUTHOR(S): E. Chenevey, H. Hanson, M. Sakowitz, M. Tan
CONTRACT NO: F33615-72-C-1148
CONTRACTOR: Celanese Corp.
PROJECT MONITOR: D. Starks (AFML/LTN)
PROJECT NO: 329-2
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The purpose of this program was to establish manufacturing methods for poly(bisbenzimidazobenzophenanthrolinedione) (BBB) fibers by designing and operating a pilot plant with a production capability of thirty pounds per week. Specifications for raw materials were developed and successful operation of the molten antimony trichloride polymerization process was demonstrated in the pilot plant. Spinning development was limited by a lack of sufficient polymer. However, excellent quality spinning dopes were made in the pilot plant. Coupled with corrosion resistant spinning pumps, stable spinning was achieved over a period of 20 hours. Drawing, using the hot nitrogen tubes designed for PBI drawing, was much improved over previous furnace set-ups. A preliminary design for a 0.5MM pound per year plant based on this process was made.

REPORT NO: AFML-TR-75-44 AD B 006 837 L
ACCESS NO: 203,855 April 1975
TITLE: LASER DRILLING
AUTHOR(S): L. M. Heglin
CONTRACT NO: F33615-73-C-5006
CONTRACTOR: General Electric Co.
PROJECT MONITOR: J. Williamson (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A project has been conducted to advance and demonstrate manufacturing methods for laser drilling small diameter holes with large depth to diameter ratios. The objectives of the program were to establish a cost effective, optimized small hole drilling process for current and future engine configurations, and to provide the engine industry with a high degree of confidence for the utilization of laser drilled holes in highly stressed components.

REPORT NO: AFML-TR-75-62 AD B 006 891 L
ACCESS NO: 203,854 April 1975
TITLE: SUPERPLASTIC FORMING OF TITANIUM STRUCTURES
AUTHOR(S): C. Hamilton, G. Stracher, J. Mills, H. Li
CONTRACT NO: F33615-73-C-5005
CONTRACTOR: Rockwell International Corp.
PROJECT MONITOR: J. Williamson (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This program was directed at the establishment of superplastic forming of Ti-6Al-4V and Ti-6Al-2Sn-4ZR-2Mo alloys as a production process. Forming studies were pursued to evaluate the process parameters of superplastic forming and to extend the process to forming aircraft structural components. A detailed study was carried out on the effect of forming parameter variations with the two titanium alloys and two configurations. It was found that the degree of forming was directly related to time at pressure at elevated temperatures. Substantial cost savings were shown to be possible through the use of superplastic forming of titanium sheet metal by reducing overall fabrication time and by providing the capability to eliminate assemblies and producing simpler, more efficient, monolithic structures.

REPORT NO: AFML-TR-75-102
ACCESS NO: 203,848 July 1975
TITLE: MANUFACTURING PROCESS FOR THE DENSIFICATION OF COMPLEX SHAPED WOVEN COMPOSITE PREFORMS
AUTHOR(S): D. Wetzler
CONTRACT NO: F33615-72-C-1665
CONTRACTOR: McDonnell Douglas Astronautics
PROJECT MONITOR: H. Materne (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The purpose of this project was the development and establishment of a manufacturing process for the densification of low cost, quality woven preform carbon structures. The objective of this program was to provide manufacturing methods for: complete automation of the densification operation, continuous high speed packing fully coordinated with other loom operations, packing of weaving yarns to consistent and reproducible densities, capability for a wide range of densities and distortion-free packing of preforms. Accomplishment of these objectives has yielded a proven economical process capable of producing various interwoven, multidimensional composites, having a variety of end item materials, designs, and fabrication patterns.

REPORT NO: AFML-TR-75-108
ACCESS NO: 200,710 September 1975
TITLE: NONCONSUMABLE MELTING OF TITANIUM
AUTHOR(S): G. D. Willette
CONTRACT NO: F33615-72-C-1126
CONTRACTOR: Teledyne Titanium
PROJECT MONITOR: K. Love (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Nonconsumable skull melting was evaluated as a titanium alloy production process for critical aerospace applications. Both titanium nitride and tungsten carbide inclusion defects were removed in melting through a gravity separation and entrapment in the skull mechanism. Numerous raw material forms including machinig chips can be utilized, making the process cost effective. Turbine engine compressor disks made from nonconsumable melted material were evaluated and found to have acceptable quality and mechanical properties.

REPORT NO: AFML-TR-75-110
ACCESS NO: 203,128 August 1975
TITLE: MANUFACTURING METHODS FOR THERMAL EXPANSION MOLDING OF ADVANCED COMPOSITES AIRCRAFT STRUCTURE
AUTHOR(S): W. Cremens
CONTRACT NO: F33615-74-C-5150
CONTRACTOR: Lockheed-Georgia
PROJECT MONITOR: H. Reinert (AFML/LTN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The purpose of this contract is to establish a manufacturing method for fabrication and assembly of advanced composite primary aircraft structures that will be cost-competitive with comparable aluminum structures. The specific goals of this program are to (1) demonstrate and further develop an innovative molding process which uses elastomeric tooling to reduce fabrication and assembly costs while improving reproducibility, and (2) perform manufacturing process analysis and fabrication cost tracking to identify and reduce the high cost aspects and allow projections of the cost impact on production hardware.

REPORT NO: AFML-TR-75-111
ACCESS NO: 202,878 July 1975
TITLE: MANUFACTURING METHODS FOR FABRICATION AND ASSEMBLY OF ADVANCED COMPOSITE PRIMARY AIRCRAFT STRUCTURE
AUTHOR(S): L. May, R. Goad
CONTRACT NO: F33615-74-C-5086
CONTRACTOR: General Dynamics Convair Div.
PROJECT MONITOR: H. Reinert (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A two-phase program was conducted to investigate process parameters and manufacturing techniques relevant to fabricating primary aircraft structure from advanced composite thermoformable material. Forming and joining techniques investigated in the preliminary phase were applied in the final phase to component fabrication. Six graphite/polysulfone strakes were fabricated for the YF-16 aircraft. The composite component is interchangeable with the metal component except for the fasteners used to attach the strake to the aircraft, and it weighs 40% less. Cost studies associated with the fabrication of graphite/polysulfone components revealed significant savings in labor. In a production run, tooling cost for graphite/polysulfone parts remains the same as for a limited number of parts. When this cost is amortized over a large production run it becomes a small portion of the total part cost. Added cost savings can result from raw material control and storage, and lower scrappage rates.

REPORT NO: AFML-TR-75-114 AD B 008 529 L
ACCESS NO: 204,101 August 1975
TITLE: MANUFACTURING METHODS TO PRODUCE HIGH DIELECTRIC CONSTANT MATERIALS FOR MICROWAVE APPLICATIONS
AUTHOR(S): A. Paladino, L. Lesensky, H. Miller, et al.
CONTRACT NO: F33615-73-C-5018
CONTRACTOR: Raytheon Co.
PROJECT MONITOR: E. Tarrants (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Manufacturing methods and facilities were established to produce low loss, temperature stable, high dielectric constant materials suitable for microwave device application such as beam forming networks for ECM radar, microwave integrated circuits, resonator-filters and ferrite phase shifters. Batches of 150 lbs. of barium tetratitanate (K-38) were produced. A split cavity technique was developed for non-destructive microwave evaluation of large-area K-38 substrates. The suitability of K-38 was successfully demonstrated for beam forming networks, microwave integrated circuits,and resonator-filters by fabricating and evaluating five samples of each. Good surface finish and low dielectric loss were thus shown.

REPORT NO: AFML-TR-75-115 AD B 008 582 L
ACCESS NO: 201,787 September 1975
TITLE: MANUFACTURING METHODS FOR RAPIDLY CURING ADVANCED COMPOSITES
AUTHOR(S): J. Mahon, S. Richter, J. Kouchinsky
CONTRACT NO: F33615-73-C-5036
CONTRACTOR: Grumman Aerospace Corp.
PROJECT MONITOR: P. Pirrung (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The results of a sequential, three-phase program, beginning with a determination of the physical properties of RF-cured advanced composites and ending with a production demonstration of the established process are reported. In Phase I (process development), a production-size rapid curing facility was established. During Phase II (process demonstration), boron/epoxy F-14A horizontal stabilizer small bays and graphite/epoxy F-111A shoulder panels were successfully molded using 90-minute RF-curing cycles. In Phase III (RF curing of non-bleed matrix laminates), advanced composites with non-bleed matrices (polyarylsulfone thermoplastics) were formed at temperatures above 500 using RF energy and conventional bagging procedures. In Phase IV (cost effectiveness of the rapid curing process), cost studies were made which include processing and support equipment and required services for a production rapid curing facility, and power requirements for RF curing graphite/epoxy and boron/epoxy laminates selected thicknesses, were established.

REPORT NO: AFML-TR-75-145 AD B 008 862 L
ACCESS NO: 203,059 September 1975
TITLE: LOW COST MANUFACTURING CONCEPTS OF ADVANCED COMPOSITE PRIMARY AIRCRAFT
AUTHOR(S): D. Stansbarger, et al.
CONTRACT NO: F33615-74-C-5153
CONTRACTOR: Northrop Corp.
PROJECT MONITOR: T. Reinhart (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Test data on the effects of the synergistic manufacturing methods on the mechanical, physical, and dimensional properties of the selected advanced composite system are reported under Task I. The synergistic manufacturing approach developed on this program was shown to be a viable cost competitive approach to the fabrication of fuselage structures. The integration of cocuring, vacuum pressure curing, no resin bleed, reusable rubber vacuum bags,and ion graphing techniques provides a production manufacturing approach which will reproducibly produce structurally sound graphite and graphite-fiberglas/epoxy hybrid primary aircraft structures on a cost competitive basis with their aluminum counterparts at a substantial weight savings. In concert with this cost savings is a concurrent weight savings of approximately 40 percent.

REPORT NO: AFML-TR-75-150 AD B 008 691 L
ACCESS NO: 204,102 October 1975
TITLE: AUTOMATED DIRECTIONAL SOLIDIFICATION OF SUPERALLOYS
AUTHOR(S): R. Kanaby, G. Vonnegut
CONTRACT NO: F33615-74-C-5007
CONTRACTOR: Detroit Diesel Allison Div.
PROJECT MONITOR: G. Glenn, J. Elbaum (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: An 18 month, 2-phase program was conducted to establish a low-cost process suitable for automated production of directionally solidified airfoil castings. The basic casting process used in the program utilized an exothermic material for preheating molds, rather than induction mold heating apparatus commonly used. Phase I effort involved characterization and refinement of the basic process to a degree which ensured ultimate capability for commercial application. Phase II effort involved 28 molds of TF41 turbine blades and vanes, poured as a pilot production demonstration lot. Based on casting quality obtained, the process was judged capable of producing directionally solidified blades on a commercial scale at estimated cost no more than 90% greater than equiaxed casting costs.

REPORT NO: AFML-TR-75-174
ACCESS NO: 204,123 October 1975
TITLE: SUMMARY REPORT ON THE AIR FORCE/INDUSTRY COST REDUCTION PROGRAM RADAR PANEL, PHASE II
AUTHOR(S): Staff Report
CONTRACT NO: N/A
CONTRACTOR: Boeing Co.
PROJECT MONITOR: Maj. Bellem (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The Radar Panel of the USAF/Industry Cost Reduction Program was sponsored by AFML and has identified 22 specific candidate cost reduction items to reduce the 25% upward spiral or radar system acquisition costs. This work has been done in two phases and this document summarizes the Phase I work that identified the high cost radar system elements as well as the Phase II work that identifies the specific cost reduction items.

NONMETALLIC MATERIALS DIVISION (AFML/MB)

REPORT NO: AFML-TR-70-278, Pt. V — AD B 007 656 L
ACCESS NO: 203,981 — May 1975
TITLE: HYBRID FLUOROSILICONES FOR AIRCRAFT FUEL TANK SEALANTS. SYNTHESIS OF FLUOROCARBON/FLUOROSILICONE HYBRID COPOLYMERS, PERFLUOROETHER OLIGOMERS AND RESIN HYBRID BLOCK COPOLYMERS
AUTHOR(S): Y. Kim, M. Riley, G. Cappo, P. Carter
CONTRACT NO: F33615-74-C-5046
CONTRACTOR: Dow Corning Corp.
PROJECT MONITOR: W. Griffin (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The syntheses and evaluations of alternating copolymers having *LS/FCS-210 ratios of 1/1, 1.5.1, and 2/1 have been accomplished. All of the copolymers are superior to LS in terms of high temperature reversion resistance, and their low temperature properties were considerably improved over those of the FCS-210 homopolymers. The preliminary evaluation results indicate that the random copolymer is somewhat less reversion resistant than the alternating copolymers. Peroxide vulcanization of a block copolymer produced an elastomer with good tensile strength and flexibility. Solvent extraction studies and behavior after vulcanization provided further information about the structure of the block copolymer products.

REPORT NO: AFML-TR-71-2 — AD B 007 440 L
ACCESS NO: 203,895 — January 1975
TITLE: POLYMER STRUCTURES AND PROPERTIES, PART IV, THERMALLY STABLE POLYMERS
AUTHOR(S): G. Berry
CONTRACT NO: F33615-70-C-1058
CONTRACTOR: Carnegie-Mellon University
PROJECT MONITOR: Dr. T. Helminiak (AFML/MBP)
PROJECT NO: 7340
TASK NO: 734004
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Creep and recovery measurements of polybisbenzimidazobenzophenatholinedione (BBB) over the temperature interval 30 to 500°C (in vacuo) have been augmented by x-ray diffraction, isothermal construction, and solubility measurements. The principal mode of creep gives rise to fully, recoverable Andrade creep for which the strain is proportional to the cuberoot of time. The stress-strain behavior of a material exhibiting Andrade creep (for which the creep compliance is linear in the cube-root of time) and the recoverable strain after the stress has been removed have been calculated for loading at constant strain rate $\dot{\varepsilon}$ and stress rate $\dot{\sigma}$. The results of the calculations are compared with the experimentation. Isochronal dynamic mechanical (10 Hz) measurements and differential scanning calorimetry are reported on films of BBB over the temperature range 100 to 500°C.

REPORT NO: AFML-TR-71-24, Pt. IV — AD B 001 146 L
ACCESS NO: 203,297 — August 1974
TITLE: HIGH TEMPERATURE RESISTANT ELASTOMERS OR COMPLIANT POLYMERS
AUTHOR(S): R. Jones, H. Cassey, C. Bertino
CONTRACT NO: F33615-71-C-1397
CONTRACTOR: TRW Systems
PROJECT MONITOR: T. Graham (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report describes the exploratory development and evaluation of elastomeric or compliant polyimides as integral fuel tank sealant for use over wide temperature (ultimate -65° to 600°F) ranges. Polymer based on bis (3,4-carboxyphenoxyphenyl) sulfone dianhydride (BSDA), 4,4'-methylene dianiline (MDA), diaminostilbene (DAS) and 1000 mol. wt. polyaliphalic ether diamine (PED) intermediate exhibited promise as a 40° to 450°F sealant, but efforts to formulate a high solids processable sealant system were unsuccessful. A similar polymer which utilized an aminophenyl terminated perfluoroether oligomer as the flexible polymer segment was found to be compliant and thermally stable in JP-7 fuel and N_2 at temperatures up to 550°F. Additional data is required to determine whether or not this type of polymer is non-corrosive to titanium, adheres adequately to this type of substrate, and if it is amenable to formulating a high solid processable sealant system.

REPORT NO: AFML-TR-72-142, Pt. III — AD B 002 787
ACCESS NO: 203,409 — March 1975
TITLE: HIGH TEMPERATURE THERMALLY STABLE GREASES
AUTHOR(S): A. Dobry, et al.
CONTRACT NO: F33615-71-C-1439
CONTRACTOR: Amoco Oil Co.
PROJECT MONITOR: J. Christian (AFML/MBT)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Friction modifiers in grease made by thickening Krytox 143 AD fluid with AMT-9 did not improve bearing life. Different preparations of AMT-9 gave greases in Krytox 143 AD with different test lives. The coarsest preparation of AMT-9 gave a grease with the longest bearing life. Three different polyphenylenes gave greases from F6-7039 fluid with poor bearing lives but gave greases from Krytox 143 AD fluid with good bearing lives. Addition of F6-7039 fluid improved thickener efficiency of greases from two of these thickeners in Krytox 143 AD.

REPORT NO: AFML-TR-72-179, Pt. III
ACCESS NO: 203,434 — October 1974
TITLE: THERMOCHEMICAL ABLATION OF AROMATIC/HETEROCYCLIC POLYMERIC COMPOSITES, PART III: MATERIAL ELEMENTAL COMPOSITION PERFORMANCE OPTIMIZATION
AUTHOR(S): H. Tong, et al.
CONTRACT NO: F33615-71-C-1490
CONTRACTOR: Acurex Corp.
PROJECT MONITOR: R. Farmer (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Previous studies have developed a thermochemical predictive technique which has been shown to be a reliable method of predicting ablative response of carbon reinforced polymer composites. This study investigates the adequacy of this technique in predicting the response of a wider range of intermetallic, non-metallic, and metallic materials. The technique is extended to a computer code which is capable of optimizing on composite material composition in order to minimize ablation rates.

AFML/MB

REPORT NO: AFML-TR-72-191, Pt. III — AD B 000 726 L
ACCESS NO: 203,218 — October 1974
TITLE: MATERIALS AND APPROACHES FOR IMPROVED STRESS CORROSION INHIBITIVE COATINGS
AUTHOR(S): C. Mitchell, G. Hurley
CONTRACT NO: F33615-74-C-5016
CONTRACTOR: Tyco Laboratories, Inc.
PROJECT MONITOR: D. Prince (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Stress-corrosion prevention systems for high strength aluminum alloys are primarily aimed at the exclusion of the corrosive environment from the metal surface. In those cases, however, it is known that the loss of integrity in the coating leads to failure by SCC. In previous work we have shown that stress corrosion can be controlled by means of anodized coatings formed by anodization in molten nitrate baths. In the present case, the conditions for carrying out the anodization treatments were optimized to yield more uniform and reproducible films. Further process variables, anodization time,and impregnation procedures were also investigated to give maximum protection. Finally, the effect of the coating on fatigue and corrosion fatigue was determined and compared to MIL Spec anodized coatings.

REPORT NO: AFML-TR-72-223, Pt. III — AD B 001 047 L
ACCESS NO: 203,294 — September 1974
TITLE: ADVANCED REENTRY MISSILE HEATSHIELD MATERIALS, PART III: HIGH STRAIN/STRENGTH FIBER MULTIDIRECTIONAL REINFORCED THERMALLY STABLE MATRIX COMPONENTS
AUTHOR(S): P. Roy, et al.
CONTRACT NO: F33615-71-C-1659
CONTRACTOR: Avco Government Products Group
PROJECT MONITOR: R. Farmer (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The report summarizes the results of exploratory materials development evaluations undertaken for the development of high strain/strength fiber reinforced thermally stable matrix composites. The feasibility of processing Avco 3D composite materials constructed of high strain/strength Thornel 300/ Thornel 400 in combination with Ciba-Geigh P105A polyimide resin was investigated. Exploratory resin processing and materials fabrication evaluations as related to radial/lateral material fabrication and matrix densification were undertaken. Techniques for pregging the high strain/strength reinforcements with P105A resin for use in molding of unidirectional composites for use as radial material and for use in fabricating prepregged tape for lateral (hoop and axial) winding were developed.

REPORT NO: AFML-TR-72-229, Pt. III — AD B 001 433 L
ACCESS NO: 203,295 — August 1974
TITLE: DEVELOPMENT OF HIGH TEMPERATURE FUNCTIONAL FLUIDS
AUTHOR(S): B. Hamon, T. Psarras
CONTRACT NO: F33615-71-C-1406
CONTRACTOR: PCR, Inc.
PROJECT MONITOR: C. Snyder (AFML/MBT)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The photochemical oxidation of hexafluoropropylene was studied. The method was developed to a continuous process yielding a mixture of carbonyl fluoride oligomers of the structure $CF_3O(CF_2O)_mCF_2COF$ and $CF_3O(CF_2)_mCOF$. Treatment of this mixture with catalytic amounts of potassium fluoride was found to effectively decompose the fluoroformate terminated oligomers, thus leaving a mixture of acyl fluoride oligomers which can be separated by fractional distillation. The addition of hexafluoropropylene oxide to carbon fluoride oligomers was studied and a series of acyl fluorides of the structure $CF_3O(CF_2O)_mCF_2CF_2O\left[CF(CF_3)CF_2O\right]_n$-$CF(CF_3)COF$ was prepared. A series of s-triazines derived from these oligomers was prepared. These triazines exhibit lower pour points by 30-50° F than equivalent triazines derived from TFEO or HFPO.

REPORT NO: AFML-TR-72-290
ACCESS NO: 203,359 November 1974
TITLE: HYDROFLUOROCARBON SEALANTS WITH IMPROVED LOW TEMPERATURE AND STRESS CORROSION PROPERTIES
AUTHOR(S): W. Anspach
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: W. Anspach (AFML/MBE)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Hydrofluorocarbon integral fuel tank sealants have been prepared which exhibit significantly improved low temperature and stress corrosion properties. These sealants should have a useful temperature range of -50° F to +550° F in hydrocarbon fuel environments. The base polymer for these Air Force Materials Laboratory (AFML) developed sealants is an experimental hydrofluorocarbon elastomer, LD-487LV, by the E.I. du Pont de Nemours Company. This report discusses compounding effects, evaluation of adhesion enhancement techniques, and a basic investigation of the stress corrosion susceptibility of titanium substrates in contact with the sealants and compounding ingredients contained in them. Data is presented and discussed which demonstrates both the advantages and limitations of these fuel tank sealing materials.

REPORT NO: AFML-TR-73-90, Pt. II AD B 000 946 L
ACCESS NO: 203,217 October 1974
TITLE: LONG LIFE ELASTOMERIC AIRCRAFT HYDRAULIC SEALS
AUTHOR(S): K. Miller, K. Ksieski, L. Hiltner
CONTRACT NO: F33615-73-C-5122
CONTRACTOR: Parker Hannifin Corporation
PROJECT MONITOR: R. Headrick (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The continued development work of long life elastomeric hydraulic seals for -65° F to +450° F/4000 psig service has shown very encouraging results. By optimizing compounds, which were based on commercially available elastomers, it has been possible to meet several goals within this temperature range. Initial results indicate that greatly improved broad temperature range seals can be developed through compound improvement of the low temperature experimental fluorocarbon elastomers by increasing extrusion resistance and reducing high temperature compression set. This approach coupled with the development of improved anti-extrusion devices will be investigated.

REPORT NO: AFML-TR-73-119, Pt. II — AD B 000 589 L
ACCESS NO: 203,209 — June 1974
TITLE: SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS
AUTHOR(S): L. Breed, J. Wiley, Jr.
CONTRACT NO: F33615-72-C-1627
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: Dr. H. Rosenberg (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Methods of synthesis were developed for phenyl-substituted, siloxane-modified polybenzimidazoles and polybenzoxazoles. The polymers were characterized, their solubilities determined in various solvents,and thermo-oxidative stabilities examined. Suitable procedures could not be developed for the synthesis of precursors for the corresponding polypyromellitimides. The preparation and properties of monomers, intermediates, and model compounds for each of the three polymer systems are reported.

REPORT NO: AFML-TR-73-147, Pt. II — AD B 000 591 L
ACCESS NO: 203,205 — March 1974
TITLE: GRAPHITE FIBERS FROM PITCH
AUTHOR(S): R. Didchenko
CONTRACT NO: F33615-71-C-1538
CONTRACTOR: Union Carbide Corp.
PROJECT MONITOR: W. Gloor (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Methods to measure molecular weight distributions in MP pitches have been developed. Number and weight average molecular weights and their distributions have been determined as a function of P.I., in MP pitches. Significant progress has been achieved during this report period both in the art of spinning very thin MP pitch filaments and in the understanding of structural changes that take place during the conversion of pitch fibers to high-performance carbon fibers. The properties of the carbonized monofilament in some instances exceeded the target properties.

REPORT NO: AFML-TR-73-147, Pt. III
ACCESS NO: 204,004 — July 1975
TITLE: GRAPHITE FIBERS FROM PITCH
AUTHOR(S): R. Didchenko
CONTRACT NO: F33615-71-C-1538
CONTRACTOR: Union Carbide Corp.
PROJECT MONITOR: W. Gloor (AFML/MBC)
PROJECT NO: 7320
TASK NO: 73200135
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The properties of the multifilament yarn improved over those achieved in the past. Strand tensile strength of up to 2.30 GPa (~350 Kpsi) was measured on fibers with an elastic modulus of 200 GPa (~30 Mpsi). Tests on flat plate composites with epoxy indicated good translation of properties if corrections were made for insufficient fiber loading. The absolute tensile strength of the thin nomofilament did not exceed the levels reported in the previous report, but reliable average values in excess of 3.45 GPa (~500 Kpsi) were obtained on filaments with elastic moduli of 300 GPa (45 Mpsi). The monofilament, with random or onion-skin structure, was in most respects similar to "Thornel" yarn, appeared to contain between the oriented ribbons a carbon phase which was considerably more susceptible to oxidation than the ribbons themselves. So far, only gas bubbles and some surface flaws have been identified as major structural defects in Type-P fibers.

REPORT NO: AFML-TR-73-171, Pt. II — AD B 001 297 L
ACCESS NO: 203,412 — August 1974
TITLE: NOVEL BLOCK COPOLYMERS
AUTHOR(S): P. Juliano, T. Mitchell
CONTRACT NO: F33615-72-C-1523
CONTRACTOR: General Electric Co.
PROJECT MONITOR: Dr. H. Rosenberg (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The synthesis of block polymer elastomers containing poly (2,6-diphenyl-1,4-phenylene oxide) [P_3O] hard segments and poly [3-heptafluoroisopropoxypropyl-methylsiloxane] [FES] soft segments was accomplished. Factors affecting the synthesis of these P_3O-FES block polymers were the difunctionality of disiloxanol-terminated FES oligomers, the structure of the amino-silane coupling agent, the polymerization temperature, and the solids level during polymerization. The resulting P_3O-FES block polymer elastomers (FES derived from M_5R cyclic trimer) exhibited better tensile properties than comparable silica-filled heat-cured FES (M_5R) elastomers. Solvent resistance and thermal stability were below anticipated levels for these materials.

REPORT NO: AFML-TR-73-199, Pt. II
ACCESS NO: 204,003 — June 1975
TITLE: RADIANT HEATING OF AEROSPACE MATERIALS PT II: LASER EFFECTS PREDICTION PROCEDURE CODE
AUTHOR(S): J. Ferrell, H. Tong, et al.
CONTRACT NO: F33615-72-C-1774
CONTRACTOR: Aerotherm Division/Acurex Corp.
PROJECT MONITOR: R. Farmer (AFML/MBC)
PROJECT NO: 7342
TASK NO: 734202
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A procedure for predicting the response of metals and nonmetals to laser heating was developed. This procedure makes use of computer codes which were developed for reentry vehicle ablation studies and were sufficiently general so that they could be modified for radiation dominated heating at flux levels which are representative of current and anticipated laser sources. The results of this development is the Aerotherm Prediction Procedure for Laser Effects code.

REPORT NO: AFML-TR-73-242, Pt. II — AD A 004 843
ACCESS NO: 203,459 — September 1974
TITLE: DEVELOPMENT OF BEARING AND LUBRICANT TEST EQUIPMENT
AUTHOR(S): J. Kissel, R. Stockwell, et al.
CONTRACT NO: F33615-73-C-5087
CONTRACTOR: Battelle
PROJECT MONITOR: R. Benzing (AFML/MBT)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Two experimental apparatuses have been designed, constructed, and delivered to the Air Force Materials Laboratory. These apparatuses will be used to develop experimental data which can be used to devise accelerated life tests for bearings for mechanically despun antenna drive systems for Air Force communications satellites. The two apparatuses were designed for the purposes of studying lubricant torque variations and lubricant quantity in ball bearings operating in vacuum.

REPORT NO: AFML-TR-73-275 AD B 001 822L
ACCESS NO: 203,347 August 1974
TITLE: IMPROVED ATJS GRAPHITE, Pt. I MATERIALS AND PROCESS STUDIES
AUTHOR(S): J. Criscione, J. Fisher, R. Booth
CONTRACT NO: F33615-72-C-1939
CONTRACTOR: Union Carbide Corporation
PROJECT MONITOR: J. Latva (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Changes in the particle size distribution of the molding mixture, thermal treatment of the base filler particles, and the mixing and forming operation for the manufacture of grade ATJS graphite were investigated in an attempt to improve its tensile strength and strain-to-failure. As a result of these investigations, modifications were made in the ATJS manufacturing process which provided a 16-percent increase in tensile strength and a 24-percent increase in strain-to-failure over that of production Grade ATJS graphite.

REPORT NO: AFML-TR-73-280
ACCESS NO: 203,356 January 1975
TITLE: COMPUTER ANALYSIS OF THE MASS SPECTRA OF GAS MIXTURES
AUTHOR(S): I. Goldfarb, R. Pritchard
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr.Goldfarb (AFML/MBP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Thermally stable polymeric materials are critically needed for development into new plastics, composites, fibers, adhesives, coatings, and elastomers for potential use in future Air Force systems under extreme environments. One means of studying the effects of high temperature on such materials is to subject them to a controlled thermal environment and to observe the resulting weight loss and evolved gases as a function of elapsed time and temperature change. A compositional analysis of the gases, along with weight loss data, is indispensable in formulating mechanisms for the degradation that results from this environment. This report describes the development of a complex computer package which can be utilized to solve the extremely difficult problem of analyzing gas mixtures from their mass spectra.

REPORT NO: AFML-TR-74-195 AD A 004 200
ACCESS NO: 203,255 October 1974
TITLE: DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES
AUTHOR(S): A. Bossert, V. Hopkins
CONTRACT NO: F33615-73-C-5069
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: F. Brooks (AFML/MBT)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Absolute viscosity, kinematic viscosity, density, and secant bulk modulus values determined for seven lubricating fluids are presented. The determinations were made with falling weight viscometer at temperatures of 100°, 210°, and 300° F. and at pressures ranging from atmospheric to 160,000 psi. Plots of absolute viscosity and density are given and all results are discussed. The equipment used to make the determinations is described and the procedures followed to collect data and reduce to fluid property values are outlined.

AFML/MB

REPORT NO: AFML-TR-74-196, Pt. I — AD B 001 823 L
ACCESS NO: 203,306 — September 1974
TITLE: MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES
AUTHOR(S): R. Novak
CONTRACT NO: F33615-73-C-5090
CONTRACTOR: United Aircraft Corp.
PROJECT MONITOR: G. Husman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report describes the first year's efforts in which the impact resistance of boron and graphite reinforced resin matrix composites was to be studied and optimized. During the first task the effect of several material variables on impact behavior was examined using 5.6 mil boron/PR-286 epoxy as the reference material. Static properties, as well as Charpy and ballistic impact response, were measured for all materials. Of the materials variables investigated, the fiber characteristics and the interfacial fiber-matrix bond strength were found to play important roles in the impact response of the composites. Two approaches were investigated for improving the impact behavior of the composites: hybridization of the reinforcement in which boron and S-glass were combined, and utilization of thermoplastic matrix resins having greater energy absorbing ability than commonly used epoxies.

REPORT NO: AFML-TR-74-196, Part II — AD B 007 239 L
ACCESS NO: 203,894 — June 1975
TITLE: MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES, PART II
AUTHOR(S): R. Novak
CONTRACT NO: F33615-73-C-5090
CONTRACTOR: United Technologies Corp.
PROJECT MONITOR: G. Husman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report describes the impact resistance of boron and graphite reinforced specimens to be optimized. The results of a series of static and normal ballistic impact tests on graphite hybrids with epoxy and polysulfone matrices and on a boron hybrid with polysulfone matrix are described. It is demonstrated that the best impact resistance is obtained with carbon/glass/polysulfone and boron/glass/polysulfone. Testing of these and several other materials under impact conditions more closely simulating those encountered by gas turbine engines is described. Again the same two materials are shown to have the best overall performance. Finally, the effects of through-thickness reinforcement and metallic sheaths as impact protection schemes are discussed.

REPORT NO: AFML-TR-74-199 — AD B 001 643 L
ACCESS NO: 203,337 — November 1974
TITLE: SYNTHESIS OF HIGH MOLECULAR WEIGHT "PARA"-PHENYLENE PBI
AUTHOR(S): Dr. R. Kovar, Dr. F. Arnold
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. F. Arnold
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: A new class of aromatic polyamide materials has recently become commercially available which exhibit super mechanical properties. The properties are primarily connected to the all-"para" aromatic structure of these polyamides. This report is concerned with the synthesis of an all-"para" aromatic heterocyclic polymer system.

REPORT NO: AFML-TR-74-201, Pt. I AD A 009 515
ACCESS NO: 203,484 June 1974
TITLE: FLUIDS, LUBRICANTS, FUELS, AND RELATED MATERIALS
AUTHOR(S): E. Klaus, et al.
CONTRACT NO: F33615-73-C-5101
CONTRACTOR: Penn. State U.
PROJECT MONITOR: G. Morris (AFML/MBT)
PROJECT NO: 7343
TASK NO: 734303
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Oxidation studies with a variety of fluids at high temperatures are presented. These studies emphasize the evaluation of oxygen tolerance of the fluids as opposed to conventional tests measuring the stable life or induction period of fluids. A lubrication model based on metal-fluid interaction in the concentrated contact is proposed. Environmental conditions in the concentrated contact are shown to be capable of providing fluid degradation products. Some preliminary data on the effect of several materials on the wear behavior of steel-on-titanium and titanium-on-titanium are presented. Bulk modulus measurements for some Spec. MIL-H-83282 are given.

REPORT NO: AFML-TR-74-208, Pt. I AD A 007 851
ACCESS NO: 203,416 November 1974
TITLE: WATER-BASE COATINGS
AUTHOR(S): M. El-Aaser, et al.
CONTRACT NO: F33615-73-C-5179
CONTRACTOR: Lehigh University
PROJECT MONITOR: D. Prince (AFML/MBE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The purpose of this work was to develop water-based analogs of existing solvent-based epoxy primer and polyurethane topcoat systems. The approach was to prepare aqueous emulsions of both epoxy and polyurethane system components using the anionic sodium lauryl sulfate-cetyl alcohol or cationic hexadecyltrimethylammonium bromide-cetyl alcohol combinations as emulsifier. The preparation of polyurethane emulsions is complicated by the reactivity of the isocyanate groups with water. Therefore, the isocyanate prepolymer was pre-reacted to give adducts that were emulsified using the anionic mixed emulsifier combination and simple stirring, followed by ultrasonic irradiation of homogenization. Both fully-cured and air-drying adducts gave fluid, stable emulsions which dried to tough, flexible films.

REPORT NO: AFML-TR-74-218 AD B 004 283 L
ACCESS NO: 203,574 January 1974
TITLE: INVESTIGATION OF CONTAMINATION EFFECTS ON THERMAL CONTROL
AUTHOR(S): T. Hughes, et al.
CONTRACT NO: F33615-73-C-5091
CONTRACTOR: McDonnell Douglas Astronautics Co.
PROJECT MONITOR: Lt. B. Price (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Results are described of highly precise measurements if deposition rates of polymeric contaminants on various types of thermal control surfaces, and their subsequent reevaporation rates under a simulated space environment. Results are also presented on the changes in bidirectional reflectance of gold mirror due to contamination and subsequent irradiation by ultraviolet energy and electrons and protons. The effect of contamination and radiation on the hemispherical reflectance and solar absorptance of second surface mirrors was also studied. The presence of radiation was found to have a profound influence on contamination kinetics, and some totally unexpected results occurred in the bidirectional reflectance measurements of the gold mirrors as they warmed from cryogenic temperatures.

REPORT NO: AFML-TR-74-222 AD B 005 700 L
ACCESS NO: 203,750 March 1975
TITLE: THERMAL FLASH RESISTANT IR SUPPRESSION COATINGS FOR ADVANCED AIRCRAFT SYSTEMS
AUTHOR(S): J. Weaver
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: J. Weaver (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: New and improved aircraft exterior coatings which offer a substantial increase in thermal flash resistance and reduced infrared emittance have been developed for use on high performance aircraft. The new coating systems, based on specially developed pigment materials, offer a 50-percent reduction in IR emittance compared to current state-of-the-art Mil-Spec coating systems over a wide spectral region encompassing bothIR suppression and nuclear thermal flash wavelengths. Coating parameters and characteristics such as pigments, binders, pigment-volume-concentration, cure characteristics, purity, coating thickness, physical and optical properties were investigated. Particular attention was devoted to reducing cost and weight along with evaluating cleanability, weatherability, and ease of application. These coatings show great promise of meeting Air Force operational requirements.

REPORT NO: AFML-TR-74-230 AD B 003 573 L
ACCESS NO: 203,535 December 1974
TITLE: POLYFUNCTIONAL FLUOROCARBON DERIVATIVES FOR CHEMICAL RESISTANT ELASTOMERS AND CROSSLINKING SYSTEMS
AUTHOR(S): T. Keller, R. Checkosky, P. Tarrant
CONTRACT NO: F33615-72-C-1333
CONTRATOR: University of Florida
PROJECT MONITOR. J. Sieron (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Trifluorovinyl trifluoromethyl ketone, $CF_2=CFC(=O)CF_3$ was prepared in a multi-step synthesis and a small sample sent to PCR,Inc. for incorporation into a nitroso elastomer. Other α,β-unsaturated carbonyl compounds made were $CF_2=CClC(=O)CF_3$, $CF_2=C(CH_3)C(=O)CF_3$, $(CF_3)_2C=CClC(=O)F$, $(CF_3)_2C=CClCO_2C_2H_5$, and $(CF_3)_2C=C(CF_3)C(=O)F$. Unsuccessful attempts were made with elemental fluorine in order to fluorinate $CF_3CC(=O)CH_2C(=O)CH_3$ or to convert $CF_3CC(=O)CCl_2C(=O)CF_3$ to $CF_3CC(=O)CF_2C(=O)CF_3$. Unsuccessful attempts were made to oxidize compounds with $-C(=O)-CF_2-$ groups to ketones or to hydrolyse compounds containing -CFI-, $-CCl_2-$, or -CClI- groups to ketones.

REPORT NO: AFML-TR-74-243 AD A 016 474
ACCESS NO: 203,851 May 1975
TITLE: INFERRING MECHANICAL RELAXATION SPECTRA, AN ILL-POSED PROBLEM
AUTHOR(S): D. Wiff, M. Gehatia
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: M. Gehatia (AFML/MBP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An effort is made to reduce the number of required mechanical measurements on resin, plastic, and composite specimens. This is achieved by proposing a technique for handling the ill-posed problem of determining a mechanical structural model of a specimen. The results are very encouraging. The report describes in detail the mathematical approach but also presents illustrative graphs comparing assumed mechanical relaxation distributions with those inferred from computer generated experimental data.

REPORT NO: AFML-TR-74-245 AD A 015 802
ACCESS NO: 203,892 December 1974
TITLE: DYNAMICS AND STATIC EVALUATION OF EXPERIMENTAL FUEL TANK SEALANT MATERIALS
AUTHOR(S): J. Baker
CONTRACT NO: F33615-72-C-1594
CONTRACTOR: Dow Corning Corp.
PROJECT MONITOR: W. Anspach (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This final technical report describes the investigation and evaluation of experimental integral fuel tank sealants under laboratory conditions simulating aircraft integral fuel tanks. Materials investigated were Dow Corning 77-028, 77-085, 3M Polyester, TRW Polyimide, Polysulfide, and AFML Viton. These materials were evaluated dynamically in a fillet sealed configuration. This report also describes in detail the functions, operational and problems encountered with the dynamic test apparatus that has been designed and fabricated for the purpose of evaluating experimental aircraft integral fuel tank sealants.

REPORT NO: AFML-TR-74-247 AD A 014 808
ACCESS NO: 203,680 April 1975
TITLE: DEVELOPMENT OF A GAS TURBINE ENGINE OIL FOR BULK OIL TEMPERATURES OF -40 TO 465°F
AUTHOR(S): F. Clark, D. Miller, S. Reid
CONTRACT NO: F33615-73-C-5079
CONTRACTOR: Monsanto Research Corp.
PROJECT MONITOR: G. Morris (AFML/MBT)
PROJECT NO: 7343
TASK NO: 734303
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Reformulation of a developmental MIL-L-27502 ester lubricant - MCS 1034A - was undertaken to produce an improved oil of greater oxidation resistance and longer shelf life. Two new formulations resulted in: (a) An oil with oxidative stability similar to the reference ester at 428°F, but with improved stability at 464°F. After 72 hours at 464°F the viscosity increase of the new fluid is only one-half that of the reference; the acid number is about one-third that of the reference; (b) An oil with oxidative properties comparable to the reference ester but with improved storage life. Five gallons of fluid (a) were blended and forwarded to WPAFB for further evaluation.

REPORT NO: AFML-TR-74-248, Part I — AD B 008 032 L
ACCESS NO: 204,009 — January 1975
TITLE: ADVANCED ABLATIVE HEATSHIELDS FOR REENTRY MISSILES, PART I: LOW RECESSION/HIGH STRENGTH PIQ MATRIX FABRICATION STUDY
AUTHOR(S): C. Hughes
CONTRACT NO: F33615-73-C-5128
CONTRACTOR: Avco Government Products Group
PROJECT MONITOR: R. Farmer (AFML/MBC)
PROJECT NO: 7340
TASK NO: 7340001
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A PIQ heterocyclic resin was selected for this study. The reinforcement (in the form of a tow) can be successfully impregnated in a continuous fashion in a vertical prepreg oven. Both Pyralin RK-5081 (polyimide) and AFR-520 resin itself can be processed effectively as fiber sizes and are compatible with the high temperature curing requirements. The procedures worked out for the slat winding method of composite construction with the "as-received" resin were not successful for NOL ring filament winding geometry.

REPORT NO: AFML-TR-74-249 — AD A 011 645
ACCESS NO: 203,572 — April 1975
TITLE: APPARATUS AND TECHNIQUES USED FOR CASTING FILMS OF AROMATIC HETEROCYCLIC POLYMERS
AUTHOR(S): M. Gehatia, A. Wereta, D. Wiff
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Capt. A. Wereta (AFML/MBP)
PROJECT NO: 7340
TASK NO: 734004
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Techniques have been developed to convert raw polymers into films by casting from solutions and evaporating to dryness. One instrument has been developed to form films from highly volatile solvents and another to form films from corrosive nonvolatile solvents. Formed films underwent post-treatment such as leaching, drying, and thermal treatment. Inducing orientation by stretching has been attempted. Film structure has been investigated with x-ray diffraction. Preliminary work included films cast from BBB, PBI, and AB-PBI polymers. Casting (high strength) PRD-49 films was attempted without success.

REPORT NO: AFML-TR-74-256, Pt. I — AD A 014 266
ACCESS NO: 203,433 — February 1975
TITLE: ACCELERATED CHARACTERIZATION OF FIBER/EPOXY COMPOSITES, PART I. VISCOELASTIC METHODS
AUTHOR(S): A. Thakker, H. Brinson, R. Heller
CONTRACT NO: F33615-72-C-2111
CONTRACTOR: Virginia Polytechnic Institute and State University
PROJECT MONITOR: J. Whitney (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Time dependent properties of angle ply laminated Boron/Epoxy and Graphite/Epoxy fiber controlled composites were investigated. The main objective of this study was to develop a technique to establish interconversion of different test results using appropriate viscoelastic theory to formulate an accelerated testing procedure. To achieve this aim, forced vibration, constant strain rate, and creep tests were performed at different temperature levels.

Multiple regression techniques were used to generate response surfaces for significant variables. Master curves using the time-temperature superposition principle were established for individual tests. Mechanical model representation integral equation formulation and numerical integration methods based on linear viscoelasticity were used to predict constant strain rate and long time creep behavior of composites from nondestructive short time dynamic tests.

REPORT NO: AFML-TR-74-260 AD B 001 862 L
ACCESS NO: 203,351 December 1974
TITLE: POLYFLUOROALKYL-ALKYL POLYSILOXANE GREASE FOR INSTRUMENT LUBRICATION
AUTHOR(S): J. Christian
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: J. Christian (AFML/MBT)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A wide temperature range grease has been developed for instruments required to operate under light to heavy loads and low to moderately high speeds. It is especially suited for use in applications involving rolling, sliding or oscillating motions and where very little wear can be tolerated. The grease is based on a fluorinated ethylenepropylene or polytetrafluoroethylene thickener in a polyfluoroalkyl-alkyl polysiloxane. Its outstanding qualities are its wide temperature range capability, its extreme pressure and anti-wear characteristics, and its non-creep nature.

REPORT NO: AFML-TR-74-278 AD A 015 727
ACCESS NO: 203,882 June 1975
TITLE: SYNTHESIS OF QUINOZALINE POLYMERS BY INTERMOLECULAR CYCLIZATION
AUTHOR(S): Dr. F. Hedberg, Dr. F. Arnold
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. F. Arnold (AFML/MBP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Polyphenylquinoxalines containing 2,2'-bis (phenylethynyl) diphenyl moieties along the polymer backbone have been synthesized. These polymers underwent a novel curing reaction consisting of an intramolecular cyclization to a dibenzoanthracene structure, thereby increasing the rigidity and correspondingly the Tg of the polymers. The significance of this type of reaction as a major breakthrough in the processing of high-temperature polymers was shown by the properties obtained for the best system: an initial Tg of 215°C cure at 245°C with no evolution of volatiles; a Tg after cure of 365°C. The initial Tg and cure temperature are compatible with current processing equipment. The nonvolatile intramolecular cure, as has been demonstrated in the phenylquinoxaline polymer system, should provide tough resins for reinforced composites with use temperatures far exceeding processing temperatures.

REPORT NO: AFML-TR-74-279 AD A 016 475
ACCESS NO: 203,897 June 1975
TITLE: SYNTHESIS OF OXYARYLENE BBB POLYMERS
AUTHOR(S): F. Arnold
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: Dr. F. Arnold (AFML/MBP)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: This work was performed to determine the extent to which processability parameters such as solubility and fusibility could synthetically be altered in the benzimidazobenzophenathroline (BBB) polymer system. The BBB polymer has excellent thermal and thermal oxidative properties; however, the polymer is infusible and is only soluble in highly corrosive solvents. A series of BBB polymers has been synthesized by the reaction of 1,4,5,8 naphthaleletetracarboxylic acid anhydride with oxyarylene tetraamines. The resulting BBB type polymers with an increased number of rotational sites along the polymer backbone were soluble in m-cresol and exhibited glass transition temperatures in the 300 - 350°C range. All of the polymers displayed good thermal and thermal oxidative stabilities characteristic of this class of materials.

REPORT NO: AFML-TR-75-11
ACCESS NO: 204,008 August 1975
TITLE: MOLECULAR TAILORING OF FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS TO LOWER GLASS TRANSITION TEMPERATURES
AUTHOR(S): R. Evers
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: R. Evers (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The synthesis of fluorocarbon ether bis (o-aminophenol) monomers was accomplished by a multistep route from long-chain fluorocarbon ether di-iodides and the reaction conditions optimized. Polycyclocondensation of these monomers with novel, long-chain fluorocarbon ether di-imidate esters led to linear fluorocarbon ether bibenzoxazole (FEB) polymers soluble in hexafluoroisopropanol and Freon 113. High fluorocarbon ether content gave the desired low glass transition temperatures without significant sacrifices in thermooxidative stabilities. Rubbery polymers with glass transition temperatures as low as -58° C were obtained. With respect to thermooxidative stability, onset of weight loss of the FEB polymers during thermogravimetric analysis in an air atmosphere occurred in the 350° - 400°C range. FEB polymers appear to have great potential as a class of polymers for broad use temperature range elastomer applications which surpass current state-of-the-art materials.

REPORT NO: AFML-TR-75-17
ACCESS NO: 204,133 August 1975
TITLE: ML-101 THERMAL CONTROL COATING SPACEFLIGHT EXPERIMENT
AUTHOR(S): D. Prince
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Prince (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: This report describes a thermal control coatings experiment conducted on the Air Force P72-1 satellite which was launched into a low earth polar orbit in October of 1972. The objectives of this experiment were to measure the amount of degradation of experimental thermal control coatings after exposure to the space environment and to correlate these results with those of space exposure for the same coatings measured in ground-based laboratory simulation equipment. Based on selected data from over 5000 revolutions covering a period of one year, it was found that all the coatings initially degraded to a greater degree than expected, possibly due to contamination. The most stable coatings were

optical solar reflectors and the least stable was a white α-Al_2O_3 pigmented coating. An experimental fabric material showed greater stability than state-of-the-art white coatings.

REPORT NO: AFML-TR-75-19, Part I
ACCESS NO: 203,846 December 1974
TITLE: GREASE LUBRICATION OF HELICOPTER TRANSMISSIONS
AUTHOR(S): B. Simmons
CONTRACT NO: F33615-72-C-2031
CONTRACTOR: Sikorsky Aircraft
PROJECT MONITOR: J. Christian (AFML/MBT)
PROJECT NO: 7343
TASK NO: 734301
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Experimental results are presented for a helicopter transmission high-speed input section operating with grease lubrication. The input section of the main transmission of the S-61 helicopter was operated with a grease lubricant conforming to military specification MIL-G-83363 (USAF). Stabilized operations were not achieved for any significant length of time at speeds higher than 50% of full operating speed. The high-speed ball bearings overheated repeatedly in attempts at high-speed orientation. The testing to date indicates that grease-lubricated operation may not be feasible at the high input speeds of the S-61 main transmission. It is recommended that a hybrid lubrication system utilizing an oil-lubricated high-speed section be evaluated.

REPORT NO: AFML-TR-75-32
ACCESS NO: 203,570 May 1975
TITLE: PERFORMANCE OF LUBRICANTS: OILS AND GREASES IN WEAR TESTS AND COMPACT MATERIALS IN BALL BEARINGS
AUTHOR(S): K. Mecklenburg
CONTRACT NO: F33615-72-C-1374
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: F. Brooks (AFML/MBT)
PROJECT NO: 7340, 7343
TASK NO: 734008, 734301
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This final report for a 3-year contract contains the results of several projects conducted on the program. The first project was a long-term repeatability study on the four-ball wear testers. The second project was to conduct four-ball wear tests on various oils and greases to determine the ability of the lubricants to prevent wear at various conditions of speed, load, and temperature. The third and fourth projects were to determine performance lives of various greases on the Pop spindles and Navy spindle. The fifth project was grease testing in the Sikorsky rigs. The last project discussed was the long-term testing of lubricant compact materials in ball bearings.

REPORT NO: AFML-TR-75-38, Part I AD B 007 253 L
ACCESS NO: 203,888 April 1975
TITLE: INVESTIGATION OF CAGE AND BEARING INSTABILITY IN DESPUN ANTENNA BEARINGS DUE TO CHANGES IN LUBRICANT PROPERTIES
AUTHOR(S): J. Kannel, S. Bupara, C. Pentlicki

CONTRACT NO: F33615-74-C-5012
CONTRACTOR: Battelle Columbus Labs
PROJECT MONITOR: Dr. M. Rivera (AFML/MBT)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A computer program is being developed for the purpose of investigating cage and bearing instability in a despun antenna bearing. The program utilizes empirical inputs to ensure accuracy of the analytical modeling and comparison with experimental cage-dynamics data are being made to validate the computer predictions. As a result of the experimental and analytical studies conducted thus far, a stability criterion is being postulated. One form of this criterion, denoting the state of stability of the system, can be written as $D_p = 4C_u^2/M_eC_s$ where C_μ is related to lubrication parameters, M_e is the effective cage mass, and C_s is a cage material-geometry parameter. If D_p is less than unity, the cage is predicted to be stable. Conversely, if D_p is greater than unity, an instability should occur.

REPORT NO: AFML-TR-75-48
ACCESS NO: 204,005 May 1975
TITLE: DEVELOPMENT OF IMPROVED CORE SPLICE ADHESIVES
AUTHOR(S): J. Mahoney, E. Crilly
CONTRACT NO: F33615-74-C-5026
CONTRACTOR: Rockwell International
PROJECT MONITOR: T. Aponyi (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A total of 16 test methods and associated target property values were selected and devised for determining the mechanical, physical, and handling characteristics of a 350°F service core splice adhesive. These were coordinated with knowledgeable people in the industry and subsequently used in the screening and characterization of various formulations. Approximately 90 materials were compounded by the formulator, of which 16 were screened for expansion ratio, slump, peak exotherm, volatile content, and uncured weight per square foot. Three of the most promising adhesives, identified as ADX-814, ADX-814.1, and ADX-815, were subject to all of the remaining tests to characterize them fully. All pertinent test procedures and data are included in this report.

REPORT NO: AFML-TR-75-53 AD B 006 394 L
ACCESS NO: 203,812 July 1975
TITLE: CORROSION BEHAVIOR OF METAL FASTENERS IN GRAPHITE-EPOXY COMPOSITES
AUTHOR(S): D. Prince
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: D. Prince (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The corrosion characteristics of metal fasteners in intimate contact with graphite-epoxy composites were studied and compared with their corrosion in aluminum. Results showed that unprotected aluminum, cadmium plated steel, and corrosion resistant steel (A286) fasteners corroded much more rapidly in graphite-epoxy composites than in aluminum. The presence of protective organic coatings slowed corrosion, but when the coatings were flawed, significant galvanic corrosion occurred. Titanium-6Al-4V and Multiphase (AMS 5758) fasteners showed no visible evidence of corrosion when in contact with graphite-epoxy composites even after 500 hours of salt spray exposure.

REPORT NO: AFML-TR-75-59 AD B 006 648 L
ACCESS NO: 203,793 May 1975
TITLE: HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS DEVELOPMENT
AUTHOR(S): J. Moraveck, H. Barnowski
CONTRACT NO: F33615-71-C-1468
CONTRACTOR: Olin Corporation
PROJECT MONITOR: G. Schmitt (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Evaluation of property data and rotating arm test results as a function of reactive oxide, pigment, and curing agent concentration resulted in the selection of a particular black fluoroelastomer formulation as a candidate rain erosion resistant, high temperature resistant coating. Development of a white fluoroelastomer formulation based on a modified procedure for introducing cross-link sites into the polymer facilitated the development of a white coating system with subsonic erosion resistance equal to MIL-C-83231 coatings. The room temperature curable fluoroelastomer coating withstands a thermal flash pulse in excess of 60 cal/cm^2 total fluence. Rotating arm test results confirm the excellent retention of erosion resistance after Florida weathering and accelerated conditionings. The recommended white fluoroelastomer coating is undergoing flight testing on an RF-4C Radome at Hill A.F.B., Utah.

REPORT NO: AFML-TR-75-61 AD B 006 264 L
ACCESS NO: 203,794 May 1975
TITLE: INFRARED TRANSPARENT POLYMERIC FILMS
AUTHOR(S): N. Bilow, et al.
CONTRACT NO: F33615-74-C-5051
CONTRACTOR: Hughes Aircraft Co.
PROJECT MONITOR: J. Weaver (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Research was conducted on fluorocarbon polymers, fluoroalkylated polyphosphazenes, and fluoroalkylated silicones in an attempt to produce infrared transparent polymers (to 6μ) suitable for use as binders in highly reflective aircraft coatings. The investigation was limited to the modification of commercially available polymers. Ambient temperature cures were sought and chemical structure modifications which had the potential of improving flow characteristics, gloss, and hardness were made. The most successful paint formulation was produced by the copolymerization of tetra fluoroethylene-vinylidene fluoride copolymer and hexafluoropropylene-vinylidene fluoride copolymer, and pigmented with barium titanate. The optical and physical properties were determined.

REPORT NO: AFML-TR-75-64 AD B 008 197 L
ACCESS NO: 204,134 October 1975
TITLE: THERMAL RESPONSE OF WOVEN AND KNITTED FABRICS IN JP-4 FUEL FIRE ENVIRONMENT
AUTHOR(S): R. Stanton, S. Schulman
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: J. Ross, S. Schulman (AFML/MBC)
PROJECT NO: 7320
TASK NO: 732002
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The heat flow process from a fire, through a clothing (fabric) system to the underlying skin was investigated both analytically and empirically. The program goal was to optimize the fiber and fabric to provide the maximum thermal protection. Both laboratory and full-scale JP-4 fuel fires were used to demonstrate the degree of correlation with data generated using analytical methods/computer code. Based on this investigation and the related flammability data obtained in laboratory and full-scale fuel fires it can be concluded that: 1) Fiber thermal stability is the most important parameter in designing thermally protective fabrics. Only two fibers, stabilized PBI and HT-4, can meet this most critical parameter. 2) Fabric weight, thickness, and optical properties are important parameters which can be adjusted by fabric design and chemical additives to yield improved protective properties. 3) Full scale fuel fire exposures have confirmed analytical and laboratory data that both stabilized PBI and HT-4 provide significantly more protection than Nomex in lightweight (4.5±0.2 ounces/square yard) fabric garments.

REPORT NO: AFML-TR-75-69
ACCESS NO: 204,038 March 1975
TITLE: DEVELOPMENT OF CORROSION RESISTANT SURFACE TREATMENTS FOR ALUMINUM ALLOYS FOR SPOT-WELD BONDING
AUTHOR(S): B. Bowen, R. Herfert, K. Wu
CONTRACT NO: F33615-74-C-5027
CONTRACTOR: Northrop Corp.
PROJECT MONITOR: T. Aponyi (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: The objective of this program was to develop a corrosion resistant spot-weld bonding system for aluminum aircraft primary structures. Anodizing and chemical surface treatment were investigated. Chemical and microscopic techniques indicated that the most suitable corrosion resistant surface on aluminum should be a boehmite surface, $\gamma Al_2O_3 \cdot H_2O$. A treatment consisting of the standard FPL etch followed by 90-minute sealing in boiling sodium dichromate solution gave a weldable surface with good corrosion resistance. Adhesives were investigated for use in the spot-welding process and a modified B.F. Goodrich A-1396B adhesive was found to be best. The selected spot-weld bonding system is FPL etch with a 90-minute dichromate seal and the modified A-1396B adhesive.

REPORT NO: AFML-TR-75-70, Part I
ACCESS NO: 203,826 May 1975
TITLE: ADVANCED PROTECTIVE MATERIALS FOR REENTRY MISSILE NOSETIPS, PART I: THREE-DIMENSIONAL REINFORCED CARBON/PLASTIC COMPOSITES
AUTHOR(S): R. Popp
CONTRACT NO: F33615-74-C-5048
CONTRACTOR: McDonnell Douglas Astronautics Co. - East
PROJECT MONITOR: R. Craig (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Advanced thermal protection materials are required for missile reentry systems to assure survival in natural and hostile environments. The most critical requirement is for shape stable nosetip materials. One promising nosetip design involves the use of a low recession apex plug with a trailing insulative plastic skirt. Silica or carbon fabric reinforced phenolics are typically used for the skirt region because of their excellent insulative properties, low ablative recession, low cost,and available fabrication techniques. These two-dimensional composites have limited potential for more demanding applications because of their low mechanical properties and interlaminar shear strength, erosion by hypervelocity particles, and degradative effects of nuclear weapons. Multidirectional carbon fiber reinforced resinous composites offer outstanding potential for alleviating these materials limitations, and for that reason, an investigation of these unique composites was performed.

REPORT NO: AFML-TR-75-71 AD B 006 836 L
ACCESS NO: 203,843 June 1975
TITLE: SHOCK LAYER SHATTERING OF WATER DROPS AND ICE CRYSTALS IN REENTRY
AUTHOR(S): W. Reinecke, G. Waldman, et al.
CONTRACT NO: F33615-74-C-5143
CONTRACTOR: Avco Systems Division
PROJECT MONITOR: G. Schmitt (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A study has been conducted to determine the amount of protection against erosion that will be provided by the shock layer to a reentry vehicle traversing a cloud of water drops or ice crystals. The methods of applying the data and correlations to flight is detailed and representative calculations of flight cases are given to illustrate the practical importance of drop breakup. The erosion protection is shown to be significant. Ballistic range tests were conducted to verify that the breakup criterion developed in the shock tube tests does indeed correspond to the condition in flight at which the drops no longer damage the vehicle surface.

REPORT NO: AFML-TR-75-72 AD A 016 525
ACCESS NO: 203,891 July 1975
TITLE: EXPLORATORY DEVELOPMENT OF COATED FABRIC FOR FIREFIGHTERS' PROTECTIVE CLOTHING
AUTHOR(S): N. Abbott, T. Lannefeld, R. Erlandson
CONTRACT NO: F33615-74-C-5117
CONTRACTOR: Fabric Research Labs
PROJECT MONITOR: S. Schulman (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of the work was to improve the durability of the aluminized fabric currently used for the outer layer of firefighters' proximity coats. Two possible improvements were developed: (a) Substituting a Viton/bronze coating for the aluminum, and adding a topcoat of pigmented urethane to improve wear resistance. Sample lengths of both types of coated fabric were produced.

REPORT NO: AFML-TR-75-77
ACCESS NO: 203,823 March 1975
TITLE: SKYLAB DO24 THERMAL CONTROL COATINGS AND POLYMERIC FILMS EXPERIMENT
AUTHOR(S): W. Lehn, C. Hurley

CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: W. Lehn (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Preliminary results of an experiment designed to determine the effects of the external Skylab space environment on the performance and properties of a wide variety of selected thermal control coatings and polymeric films are presented. Post flight analysis of the three sets of recovered thermal control coatings indicated that measured changes in specimen thermooptical properties are due to a combination of excessive contamination and solar degradation of the contaminant layer. Preliminary experimental results on the analysis of the contamination are also presented.

REPORT NO: AFML-TR-75-85, Part I AD B 007 692 L
ACCESS NO: 203,982 August 1975
TITLE: SYNTHESIS OF THERMALLY STABLE POLYMERS
AUTHOR(S): C. Marvel
CONTRACT NO: F33615-74-C-5113
CONTRACTOR: University of Arizona
PROJECT MONITOR: G. Loughran (AFML/MBP)
PROJECT NO: 7340
TASK NO: 734004
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Some aromatic polyethers, -sulfones and -ketone polymers containing units from 2,5-dicyanoterephthalic acid have been made. The extra cyano groups improve the crosslinking in these polymers. Attempts to synthesize some cyano polymers with the cyano group separated from the main chain have not been successful. Further work on the use of paracyclophane units in the backbone chain of aromatic polyethers, -sulfones and -ketone polymers has been carried out.

REPORT NO: AFML-TR-75-83 AD A 019 453
ACCESS NO: 204,108 September 1975
TITLE: AEROSPACE MATERIALS RESPONSE TO INTENSE THERMAL RADIATION
AUTHOR(S): F. Vondersaar
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: R. Craig (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A survey of methods of testing the response of materials to intense thermal radiation is given. Particular emphasis is given to simulation of the thermal flash from a nuclear weapon with a Quarty Lamp Bank. Results of several tests are shown.

REPORT NO: AFML-TR-75-86 AD B 006 859 L
ACCESS NO: 203,883 June 1975
TITLE: NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS
AUTHOR(S): K. Baucom
CONTRACT NO: F33615-74-C-5032
CONTRACTOR: PCR, Inc.
PROJECT MONITOR: Capt. R. Cochoy (AFML/MBE)

AFML/MB

PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Monomers such as perfluorinated alkylene and alkylene oxide mono-and diacetylenes, dinitriles,and vinyl ethers have been prepared and sent to the Air Force Materials Laboratory or its contractors. Polymers of vinylidene fluoride with various perfluorinated vinyl ethers have been prepared and sent to the Air Force Materials Laboratory.

REPORT NO: AFML-TR-75-90 AD B 007 909 L
ACCESS NO: 204,032 August 1975
TITLE: DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES
AUTHOR(S): R. Boschan, A. Landis
CONTRACT NO: F33615-73-C-5062
CONTRACTOR: Hughes Aircraft Co.
PROJECT MONITOR: T. Aponyi (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Several modifications of the previously studied HR 600 adhesive were chosen for investigation as addition-cured polyimide adhesives for titanium. All of the materials studied were acetylene terminated oligomers which were prepared by reacting an arylenediamine with benzophenonetetracarboxylic dianhydride (BTDA) and capping this product with either 3-aminophenylacetylene (I) or 3-(3-aminophenoxy) phenylacetylene (II), followed by imidizing in a refluxing benzene-cresol mixture or in acetic anhydride. The most promising oligomers from the standpoint of melting point, solubility, flow properties and adhesive strength were those from I, BTDA, and 1,3-di (aminophenoxy) benzene (III), designated HR 600 DP-2 (HR 600 oligomer), and from II, BTDA, and III, designated HR 650. Elevated temperature air aging tests (90 percent RH at 160°F) are very encouraging.

REPORT NO: AFML-TR-75-98
ACCESS NO: 204,039 August 1975
TITLE: DEVELOPMENT OF POLYESTER/WOOL UNIFORM FABRIC WITH IMPROVED DURABILITY AND APPEARANCE
AUTHOR(S): W. Carter, S. Henson
CONTRACT NO: F33615-72-C-1822
CONTRACTOR: Georgia Institute of Technology
PROJECT MONITOR: D. May (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The mechanism of "frosting" of polyester/wool uniform fabrics has been established. An exploratory research and development program has been carried out to establish those factors in the composition, construction, and processing of polyester/wool uniform fabrics which contribute to their wearing characteristics, particularly their pilling and frosting behavior. Based on findings, six specification fabrics exhibiting improved wear performance have been prepared for a service test program.

REPORT NO: AFML-TR-75-103 AD B 007 429 L
ACCESS NO: 203,901 July 1975
TITLE: SYNTHESIS OF PERFLUOROALIPHATIC ETHER MONOMERS
AUTHOR(S): T. Psarras
CONTRACT NO: F33615-73-C-5042
CONTRACTOR: PCR, Inc.
PROJECT MONITOR: R. Evers (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Perfluoroacyl nitriles were obtained by reaction of HFPR-oligomer acyl chlorides with silver cyanide. With primary perfluoroacyl chlorides the originally formed acyl nitrile reacts further with AgCN and RfCOCl to form α,ω-dicyanoperfluoroesters as the major product. Primary perfluoroether acyl fluorides were obtained by thermal rearrangement of perfluorovinyl ethers at 230°C. Primary perfluoroether iodides are obtained by reaction of perfluorovinyl ethers and iodine at 230°C. The preparation of a variety of perfluoroether iodides is reported.

REPORT NO: AFML-TR-75-122 AD A 018 636
ACCESS NO: 204,107 October 1975
TITLE: SURFACE ANALYSIS OF 2024 AND 7075 ALUMINUM ALLOYS AFTER CONDITIONING BY CHEMICAL TREATMENTS
AUTHOR(S): N. McDevitt, W. Baun, J. Solomon
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: N. McDevitt (AFML/MBM)
PROJECT NO: 7340
TASK NO: 73400216
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This investigation was carried out to determine the effect of various chemical treatments on the surface of 2024-T3 and 7075-T6 bare aluminum alloys. After treatment various chemical elements can be found on the surface arising from the alloy constituents, the chemical solution or tap water rinse. The chemical signature of each surface should be known to assess adhesive bond durability.

REPORT NO: AFML-TR-75-128 AD B 008 937 L
ACCESS NO: 204,106 August 1975
TITLE: PPQ ADHESIVES FOR LARGE AREA BONDING OF TITANIUM ALLOYS
AUTHOR(S): M. O'Rell, C. Sheppard, R. Vaughan, R. Jones
CONTRACT NO: F33615-74-C-5017
CONTRACTOR: TRW Systems
PROJECT MONITOR: L. Picklesimer (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734003
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A Diels-Alder reaction was investigated as a means to crosslink polyphenylquinoxalines (PPQ) which were intended for use as adhesives in large area bonding of titanium alloys. Two promising candidate polymers were identified for process development studies. Double lap-shear specimens were press cure fabricated from the adhesives and Ti-6Al-4V adherends which demonstrated room temperature strengths of 4000 psi and elevated temperature strengths of 2800 psi and 2000 psi at 450°F and 550°F, respectively. Detailed evaluation studies were conducted which included stress durability determinations, crack extension

measurements, peel strength measurements,and blister detection tests which demonstrated applicability for preparing large area bonded specimens. The results of the detailed testing indicated that the crosslinked PPQ adhesive possessed toughness and that large area bonded specimens can be press-cure fabricated.

REPORT NO: AFML-TR-75-146 AD B 008 267 L
ACCESS NO: 204,095 September 1975
TITLE: NON-SPECULAR COATINGS
AUTHOR(S): R. Peterson, P. Zimmer
CONTRACT NO: F33615-74-C-5070
CONTRACTOR: Honeywell, Inc.
PROJECT MONITOR: J. Weaver (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The main objective of this program was to develop aircraft coatings having low diffuse reflectance and low specular reflectance in the infrared (0.7 to 5.0μm) and color tailorability in the visible (0.4 to 0.7μm). Such coatings were to be developed without sacrificing the normal serviceability expected of coating systems for USAF aircraft. A second objective was to design and fabricate a portable instrument so that it could be used both in the laboratory and in the field to characterize the bidirectional reflectance of paint coatings. Three coating systems, a light grey polyurethane, an olive drab polyurethane,and an olive drab acrylic were investigated in detail. Flatting agents were used to improve gloss, durability,and handling characteristics. Comparative tests with commercially available low gloss paints demonstrated the feasibility of significant improvements with the newly developed coatings.

REPORT NO: AFML-TR-75-155 AD B 008 705 L
ACCESS NO: 204,103 September 1975
TITLE: ON THE SHAPE OF ERODING BODIES WITH APPLICATION TO BALLISTIC RANGE EROSION TESTS
AUTHOR(S): H. Buss, W. Reinicke, N. Thyson
CONTRACT NO: F33615-74-C-5149
CONTRACTOR: Avco Systems Division
PROJECT MONITOR: G. Schmitt (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The problem of the time dependent shape change bodies undergoing high speed erosion is formulated in general, and solutions given for initially spherical and parabolic bodies. The results are employed to calculate the ratio of the average mass loss ratio measured shadowgraphically in ballistic range erosion tests to the normal impact mass loss ratio.

REPORT NO: AFML-TR-75-165
ACCESS NO: 203,900 August 1975
TITLE: RESULTS OF THE POLYMERIC FILMS SKYLAB D024 EXPERIMENT
AUTHOR(S): W. Lehn, C. Hurley
CONTRACT NO: N/A
CONTRACTOR: internal

AFML/MB

PROJECT MONITOR: W. Lehn (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Results of an experiment designed to evaluate the effects of the near earth environment on the performances and properties of selected polymeric films were exposed to the Skylab space environment for varying periods of time during the mission. The individual specimen holders were retrieved during EVA by the Astronauts, placed in hermetically sealed containers, recovered, and returned to the Air Force Materials Laboratory for analysis and evaluation. Post-flight analysis of the three sets of recovered polymeric films indicated measured changes in the optical, physical, and electrical properties were due to a combination of excessive contamination, solar degradation of the polymer film materials. The degree of contamination experienced compromises the measurement of the degradation of the polymeric film themselves. Experimental results on the analysis of contamination are also presented.

SYSTEMS SUPPORT DIVISION (AFML/MX)

REPORT NO: AFML-TR-74-39, Supplement II — AD B 008 163 L
ACCESS NO: 204,048 — August 1975
TITLE: THE CARBON/CARBON ASSESSMENT PROGRAM 50 MW ABLATION TESTING AND RESULTS
AUTHOR(S): R. Maurer, C. Powars
CONTRACT NO: F33615-71-C-1215
CONTRACTOR: Aerotherm Division
PROJECT MONITOR: Capt. E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Steady state recession and shape change histories were observed for the Carbon/Carbon Assessment Program materials at 4 different conditions in the AFFDL 50 MW RENT facility. In general, the materials performed similarly with the PF 3D material maintaining laminar flow conditions better than the other carbon/carbon composites used.

REPORT NO: AFML-TR-74-207 — AD B 002 538 L
ACCESS NO: 203,389 — September 1974
TITLE: IMPROVED INSULATOR MATERIALS REQUIREMENT PROGRAM
AUTHOR(S): R. Gillian, S. Dunn
CONTRACT NO: F33615-73-C-5142
CONTRACTOR: Prototype Development Associates, Inc.
PROJECT MONITOR: C. Pratt, Jr. (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this program was to determine the materials requirements for improved insulators for carbon/carbon reentry vehicles. Systems tradeoff studies were conducted to determine significant material parameters, and an evaluation of all viable insulator candidates was made. Test data requirements are recommended for acceptance testing and for developing an engineering design data base. Recommendations for potential materials improvements are made.

REPORT NO: AFML-TR-74-229 — AD B 002 936 L
ACCESS NO: 203,438 — September 1974
TITLE: ANALYSIS OF HIGH STRAIN GRAPHITE
AUTHOR(S): J. Stanwood
CONTRACT NO: F33615-74-C-5061
CONTRACTOR: Philco-Ford Corp.
PROJECT MONITOR: Lt. G. Hollenberg (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A systematic study of thermostructural response of material properties and property variations representative of high strain graphitic materials is accomplished. An optimum combination of properties is selected. Nosetip geometries are identified which provide substantial performance advantage over AFJS graphite in the severe reentry erosion environment.

REPORT NO: AFML-TR-74-232 — AD B 006 439 L
ACCESS NO: 203,623 — June 1975
TITLE: THERMOSTRUCTURAL RESPONSE OF CARBON/CARBON MATERIALS UNDER HIGH HEAT FLUX ENVIRONMENTS

AUTHOR(S): H. Starrett, F. Weiler, C. Pears
CONTRACT NO: F33615-71-C-1566
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: Capt. C. Budde (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this program was to develop a continuum material model which could be used to predict the response of carbon/carbon materials under thermostructural loadings. The experimental material was the MOD 3a carbon/carbon. A deformation model was developed which is controlled primarily by an inplane shear response of the material. This model predicts the off-axis tensile and compressive responses that were measured in laboratory tests. The model was used in a finite element computer code to predict the thermostructural response of MOD 3a in the SoRI temperature/stress test in specimens with both xy and xz orientations. The prediction of yield or degradation zones agree qualitatively with the experimental observations.

REPORT NO: AFML-TR-74-254 AD B 002 921 L
ACCESS NO: 203,415 January 1975
TITLE: THE DEVELOPMENT AND DEMONSTRATION OF A HIGH TEMPERATURE RING TEST FACILITY
AUTHOR(S): A. Bush, J. Legg, C. Pears
CONTRACT NO: F33615-73-C-5118
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: Capt. E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of the program was to provide the engineering effort required to develop and demonstrate a high temperature capability for a "hydrostatic" ring test. A need for this capability exists in characterizing the elevated temperature hoop tensile properties of carbon/carbon heatshield materials. The program resulted in the development of a test facility for hoop tensile ring evaluations at elevated temperatures. Tests were successfully run up to a temperature of 2000°F.

REPORT NO: AFML-TR-74-259 AD A 010 425
ACCESS NO: 203,565 February 1975
TITLE: NONLINEAR DEFORMATION OF GRAPHITIC MATERIALS
AUTHOR(S): R. Jones, D. Nelson, Jr.
CONTRACT NO: F33615-73-C-5124
CONTRACTOR: Southern Methodist University
PROJECT MONITOR: Capt. C. Budde, Capt. J. Koenig (AFML/MXS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Artificial graphites have been used for the past decade in reentry vehicle nosetips. Severe design requirements are imposed on nosetips because of their operational environment. Thus, accurate stress analysis procedures are of paramount importance. A new model for the deformation behavior of this group of nonlinear transversely isotropic materials under initial loading is described. This material model, which is based on a new deformation theory of orthotropic plasticity, has excellent potential for description of the unusual phenomenon of "biaxial (multiaxial) softening" found in ATJ-S graphite.

REPORT NO: AFML-TR-74-262 AD A 013 166
ACCESS NO: 203,720 March 1975
TITLE: BIAXIAL TENSILE FRACTURE OF ATJ-S GRAPHITE

AUTHOR(S): J. Jortner
CONTRACT NO: F33615-74-C-5081
CONTRACTOR: McDonnell Douglas Astronautics Co.
PROJECT MONITOR: Capt. C. Budde, Capt. G. Hollenberg (AFML/MXS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Failure strains were measured in specimens of ATJ-S graphite fractured in biaxial tension using a test method that relies on the centrifugal forces produced by rotation to induce the desired stresses. It is shown that, at a given level of strain, the fracture probability is somewhat larger in biaxial tension than in uniaxial tension. An exploratory biaxial test on a specimen of carbon/carbon composite was conducted in the same test fixtures to demonstrate the wider applicability of the rotational method. Stress calculations using elastic and two nonlinear constitutive formulations, are presented for rotating bodies in the form of circular disks and slender bars. The validity of the various assumed stress-strain laws is discussed briefly. The possibility of designing a rotating device capable of testing cylindrical specimens in triaxial tension is discussed.

REPORT NO: AFML-TR-74-266 AD A 014 363
ACCESS NO: 203,772 February 1975
TITLE: DEVELOPMENT OF ENGINEERING DATA ON THE MECHANICAL AND PHYSICAL PROPERTIES OF ADVANCED COMPOSITE MATERIALS
AUTHOR(S): K. Hofer, D. Larsen, V. Humphreys
CONTRACT NO: F33615-73-C-5125
CONTRACTOR: Illinois Institute of Technology Research Institute
PROJECT MONITOR: M. Knight (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Data were generated on the effect of various environments on the physical, thermal, and mechanical properties of Thornel 300/Narmco 5208 composites. The environments included steady state humidity conditioning for two exposure periods, cyclic humidity conditioning which included the effects of thermal shocks and the effect of photo-degradative exposures, and steady and cyclic thermal exposures. The mechanical properties investigated included tension, compression, in-plane shear, interlaminar shear and flexural static properties, fatigue, creep and stress-rupture resistances. Overall the Thornel 300/Narmco 5208 composite system showed consistent strengths and moduli, over the range of temperatures studied (room temperature to 350°F) and after a wide variety of humidity and thermal conditioning treatments. The system possesses a high resistance to degradation of its mechanical properties after exposure to humidity and thermal conditioning.

REPORT NO: AFML-TR-74-271 AD B 001 615 L
ACCESS NO: 203,341 February 1975
TITLE: ELASTIC COMPLIANCES FOR ATJ-S GRAPHITE AND MOD 3a CARBON/CARBON
AUTHOR(S): H. Starrett, C. Pears
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: Capt. E. Ross, C. Pratt (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only

ABSTRACT: Lateral strain measurements were made on larger than normal specimens of ATJ-S graphite and MOD 3a carbon/carbon to determine whether or not the values of Poisson's Ratio given in the ATJ-S(WS) data book (AFML-TR-73-14) were reasonable over the temperature ranges of interest and to provide some Poisson's Ratio values for MOD 3a which can be used in preliminary design work.

REPORT NO: AFML-TR-75-3 AD A 008 529
ACCESS NO: 203,456 February 1975
TITLE: DURABILITY OF ADHESIVE BONDED JOINTS
AUTHOR(S): A. Marceau, W. Scardino
CONTRACT NO: F33615-74-C-5065
CONTRACTOR: Boeing
PROJECT MONITOR: W. Scardino (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This technical report is a complete survey of test methods in use or proposed by various investigators for determining the durability, under stress and adverse environments, of adhesive bonded joints and structures. Illustrations of the methods are given along with a discussion and analysis of each method. References for all methods are tabulated and a summary table is presented giving evaluation criteria and advantages and disadvantages of the various tests.

REPORT NO: AFML-TR-75-7
ACCESS NO: 203,801 April 1975
TITLE: EXPLORATORY DEVELOPMENT OF WELD QUALITY DEFINITION
AUTHOR(S): R. Witt, O. Paul
CONTRACT NO: F33615-72-C-2039
CONTRACTOR: Grumman Aerospace Corp.
PROJECT MONITOR: P. Hendricks (AFML/MXA)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The purpose of this program was to conduct an exploratory evaluation of the effects of typical weld anomalies on fatigue endurance of Ti-6Al-4V titanium alloy weldments and to propose criteria for acceptance/rejection of titanium fusion welds. The program objectives were as follows: 1) to determine the feasibility of producing typical defects in Ti-6Al-4V titanium alloy weldments by intentional variation of processing parameters, utilizing Ti-6Al-4V (STOA) plates as base materials; 2) to evaluate the effect of flaws produced intentionally in experimental welds by electron-beam (EB), plasma-arc (PA), gas-tungsten-arc (GTA), and gas-metal-arc (GMA) welding on fatigue endurance; and 3) to propose acceptance criteria for titanium fusion weldments based on correlation of fatigue test results with both nondestructive inspection and fractographic findings.

REPORT NO: AFML-TR-75-14 AD A 013 879
ACCESS NO: 203,773 June 1975
TITLE: STRESSES IN AN ADHESIVE BONDED COMPOSITE-TO-METAL ASSEMBLY
AUTHOR(S): T. Reinhart, W. Scardino
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: W. Scardino (AFML/MXE)

DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An in-house program was initiated in order to demonstrate the engineering feasibility of the use of boron/epoxy composites to add stiffness to metallic structural components. The program was designed to determine the level of the stresses induced in the boron/epoxy (B/E) composite, 321 stainless steel substrate,and in the structural adhesive joining the two adherends. Limitations in the equipment available, amount of boron prepreg on hand,and in the available NDI equipment dictated the final size and geometry of the specimen. Essentially, the specimen selected was designed to induce severe thermal mismatch stresses in the composite and in the adhesive, and was intended to be a "worst case" test specimen. After thermal cycles and 134 days humidity exposure we had been unable to detect any debonds or flaws in the assembly. C-scan and acoustic emission were utilized to monitor the component periodically throughout the exposure testing.

REPORT NO: AFML-TR-75-20 AD A 014 353
ACCESS NO: 203,783 April 1975
TITLE: STATIC AND DYNAMIC FRACTURE PROPERTIES FOR ALUMINUM ALLOY 7475-T651 AND T7351
AUTHOR(S): R. Cervay
CONTRACT NO: F33615-74-C-5024
CONTRACTOR: University of Dayton
PROJECT MONITOR: D. Watson (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A broad base of mechanical property data were developed on two plates of Al 7475. One of the 1½-inch thick plates was in the T7351 condition and one was in the T651 condition. The conditional toughness values (K_Q) for identical test conditions indicate the T7351 processing possesses the superior toughness property. The smooth and notched fatigue properties were about equal to those of other 7000-series aluminum alloys. Constant amplitude fatigue crack growth resistance was better than some older 7000-series alloys and similar to other new 7000-series alloys while the stress corrosion cracking properties in a salt water environment were excellent. Most of the tests were repeated using specimens that had been subjected to 250°F (121°C) for 1000 hours. This time-temperature exposure resulted in: (1) a slight reduction in tensile strength, (2) a slight increase in conditional toughness (K_Q) for the T651 plate and a small decrease in K_Q for the T7351 heat treated plate, (3) a slight reduction in fatigue properties, and (4) negligible effect on the fatigue crack growth rate and corrosion properties.

REPORT NO: AFML-TR-75-25, Vol. I
ACCESS NO: 203,847 April 1975
TITLE: EXPLORATORY DEVELOPMENT OF HYPERSONIC HEAT TRANSFER AND THERMOCHEMICAL ABLATION OF ADVANCED MATERIALS: NOSETIP TEST DATA EVALUATION AND ROUGH WALL TRANSITION
AUTHOR(S): K. Chen, V. DiChristina, T. Lin, T. Liu
CONTRACT NO: F33615-72-C-1803
CONTRACTOR: Avco Government Products Group
PROJECT MONITOR: Capt. G. Jumper (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The overall program study was in three specific areas: (1) evaluation of wind tunnel test data, (2) roughwall boundary layer transition, and (3) review of European turbulent boundary layer state-of-the-art. The first two topics are included in Volume I and the last topic comprises Volume II.

REPORT NO: AFML-TR-75-25, Vol. II — AD A 016 783
ACCESS NO: 203,847 — April 1975
TITLE: EXPLORATORY DEVELOPMENT OF HYPERSONIC HEAT TRANSFER AND THERMOMECHANICAL ABLATION OF ADVANCED MATERIALS
AUTHOR(S): T. K. Fannelop
CONTRACT NO: F33615-72-C-1803
CONTRACTOR: Avco Systems Division
PROJECT MONITOR: Capt. G. Jumper (AFML/MXS)
PROJECT NO: 7381
TASK NO: 73810264
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The overall program study was in three specific areas: (1) evaluation of wind tunnel test data, (2) rough wall boundary layer transition, and (3) review of European turbulent boundary layer prediction methods. In particular, work related to nosetip boundary layer phenomenology, including the effects of roughness, body curvature, preparation, and reattachment are discussed.

REPORT NO: AFML-TR-75-37, Vol. I, II, III — V II: AD A 018 886
ACCESS NO: 204,136 — V III: AD A 018 861
TITLE: DOASIS: A COMPUTER CODE FOR THE DEFORMATION PLASTIC, ORTHOTROPIC, AXISYMMETRIC, (AND PLANE) SOLUTION OF INELASTIC SOLIDS — October 1975
AUTHOR(S): F. Weiler
CONTRACT NO: F33615-74-C-0148
CONTRACTOR: Weiler Research, Inc.
PROJECT MONITOR: Capt. C. Budde (AFML/MXS)
PROJECT NO: 63311F
TASK NO: 627A0013
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Volume I (Finite Element Program) involves the finite element (displacement) method in determining the displacements, (elastic, plastic, thermal) strains and stresses, as well as effective strains and stresses in axisymmetric, constant thickness, and variable thickness plane solids, with different orthotropic, elastic-plastic, temperature dependent material properties in tension and compression including the effect of either initial strains or stresses. The continuous solid is replaced by a system of discrete finite elements having either triangular or quadrilateral cross sections. The solution of the continuous solid is reduced to the solution of a set of linear, algebraic simultaneous equations yielding the displacements, from which the strains and stresses are determined. In Volume II (Pre- and Post-processor Theoretical and Programmers' Manual), the theoretical background of the pre-processor computer programs MESHGN, TEMINT, and PRSINT and the post-processor computer programs ITEROG and CONTUR which are compatible with the finite element computer program DOASIS are described. In Volume III (Users' Manual), the computer program input data and formats are described for the pre-processor computer programs MESHGN, TEMINT, and PRSINT and the post-processor ITEROG and CONTUR programs, and for the element computer program DOASIS.

REPORT NO: AFML-TR-75-42, Vol. II
ACCESS NO: 204,110 — September 1975
TITLE: PROCEEDINGS OF THE 1974 TRISERVICE CORROSION OF MILITARY EQUIPMENT CONFERENCE, 29-31 OCTOBER, 1974, VOLUME II: SESSION IV THROUGH VII

AUTHOR(S): F. Meyer, Editor
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: F. Meyer (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report is a compilation of papers presented at the 1974 Triservice Corrosion of Military Equipment Conference held in Dayton, Ohio, 29-31 October, 1974. The purpose of the 1974 Conference was to continue inter-service coordination in the areas of corrosion research and corrosion prevention and control. Specifically, the objectives were to make Department of Defense personnel, contractors, and interested individuals aware of the important corrosion problems in military equipment, to present the status of significant corrosion research projects currently pursued by the military services and to provide a general forum for exchange of corrosion prevention and control information.

REPORT NO: AFML-TR-75-45 AD B 005 923 L
ACCESS NO: 203,760 May 1975
TITLE: EXPLORATORY DEVELOPMENT TO OBTAIN THERMAL AND MECHANICAL CHARACTERIZATION DATA ON ADVANCED CARBON INSULATION
AUTHOR(S): C. Kistler, K. Wilkes, et al.
CONTRACT NO: AFML-F33615-73-C-5096
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: C. Pratt (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report summarizes characterization methods and data for carbon fiber insulation considered for use in carbon/carbon reentry vehicles. In particular, this report includes microstructural characterization methods, mechanical compressive properties, thermophysical properties, high-temperature carbon/nitrogen reactions, and a survey of potential insulation suppliers.

REPORT NO: AFML-TR-75-58 AD A 013 877
ACCESS NO: 203,806 May 1975
TITLE: DETERMINATION OF SELECTED MIL-HDBK-5 DESIGN ALLOWABLE PROPERTIES FOR FIVE AEROSPACE MATERIALS
AUTHOR(S): P. Ruff
CONTRACT NO: F33615-73-C-5053
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: C. Harmsworth (AFML/MXE)
PROJECT NO: 7381
TASK NO: 73810336
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This annual report describes a test program to develop certain missing MIL-HDBK-5 design allowable properties for five aerospace materials: 2024-T861 aluminum alloy sheet, 17-4PH and 15-5PH precipitation hardening stainless steel bar, 9Ni-4Co-0.20C steel plate, and Ti-6Al-6V-2Sn annealed extrusion. Design allowable properties were determined in accordance with MIL-HDBK-5 guidelines.

REPORT NO: AFML-TR-75-65 AD A 015 730
ACCESS NO: 203,889 July 1975
TITLE: THE EVALUATION OF Ti-6Al-6V-2Sn PRE-ALLOYED POWDER PROCESSING

AUTHOR(S): C. Cook, A. Vaia
CONTRACT NO: F33615-73-C-5107
CONTRACTOR: Westinghouse Research Labs
PROJECT MONITOR: G. Saul (AFML/MXA)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effects of input material and powder production method on the properties of Ti-6Al-6V-2Sn powder and hot isostatically pressed powder compacts have been evaluated. The variations in input material studied were material form, structure, and chemistry while the two powder production methods examined were the solid state hydride-dehydride (HD) process and the experimental molten state, Westinghouse Durarc^{R} Process. The effect of these materials and processing variables on the tensile properties of powder compacts was largely masked by the contamination present in both the HD and Durarc^{R} Powder. While both powder processes resulted in oxygen contamination, in Durarc^{R} Powder the contamination tended to be localized in some particles and particle surfaces which produced localized brittleness and poor tensile ductility in the subsequent compacts. Metallic inclusions present in HD powder formed brittle reaction zones with the titanium alloy during pressing and heat treating which also resulted in poor tensile ductility in powder compacts.

REPORT NO: AFML-TR-75-76 AD A 018 244
ACCESS NO: 204,125 August 1975
TITLE: REENTRY VEHICLE NOSETIP STRESS ANALYSIS
AUTHOR(S): R. Jones, J. Koenig
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: C. Pratt (AFML/MXS)
PROJECT NO: 7381
TASK NO: 738102
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The design analysis problems for graphite and carbon/carbon reentry vehicle nosetips in ballistic and maneuvering trajectories are outlined. The ultimate objective is computer programs for prediction of the thermal and mechanical stress behavior of such nosetips. The steps for qualifying computer programs to attain the objective are discussed in the context of necessary laboratory experiments through flight tests. Present nosetip stress analysis computer programs are characterized, and material behavioral characteristics not properly treated are identified. Some of the problem areas are different tensile and compressive moduli; nonlinear orthotropic behavior including biaxial softening (substantially increased strains under biaxial tensile loading opposed to uniaxial loading); macroscopic inhomogeneity and asymmetry of carbon/carbon nosetips; incompletely characterized materials; and inadequate failure criteria. Future nosetip stress analysis capabilities are speculatively predicted.

REPORT NO: AFML-TR-75-97 AD A 017 848
ACCESS NO: 203,980 June 1975
TITLE: ENGINEERING DATA ON NEW AEROSPACE STRUCTURAL MATERIALS
AUTHOR(S): O. Deel, P. Ruff, H. Mindlin
CONTRACT NO: F33615-73-C-5073
CONTRACTOR: Battelle Laboratories
PROJECT MONITOR: C. Harmsworth (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: The major objectives of this research program were to evaluate newly developed materials of interest to the Air Force for potential structural airframe usage, and to provide "data sheet" type presentations of engineering data for these materials. The effort covered in this report has concentrated on 7049-T7351 plate, Inconel 617 annealed sheet, 7475-T7351 plate, 2419-T851 plate, Ti-6Al-2Zr-2Sn-2Mo-2Cr duplex-annealed forging, Ti-6Al-2Cb-1Ta-1Mo annealed plate, Ti-6Al-4V beta-annealed plate, Ti-6Al-4V annealed castings, Ti-6Al-4V isothermal forgings, Incoloy 903 heat-treated sheet, and 201.0 T7 castings.

REPORT NO: AFML-TR-75-117 AD B 007 942
ACCESS NO: 204,033 September 1975
TITLE: MICROSTRUCTURAL RELATIONSHIPS IN 2-2-3 CARBON REINFORCED CARBON COMPOSITES
AUTHOR(S): R. McSwain, C. Bates
CONTRACT NO: F33615-74-C-5029
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: Capt. E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Several 2-2-3 carbon reinforced carbon composites have been examined using light microscopy, scanning electron microscopy, and transmission electron microscopy to determine the structural relationships existing between Thornel 50 carbon fibers, chemically vapor deposited pyrolytic carbon, and a pitch impregnant. It was found that the vapor deposited carbon existed on the Thornel fibers within the yarn bundles with the c-axis of the deposited carbon parallel to the fiber axis. After CVD (chemical vapor deposition) treatment, impregnation, and graphitization, the filler material within fiber bundles exists with the c-axis of the graphite filler parallel to the fiber bundle axis.

REPORT NO: AFML-TR-75-125
ACCESS NO: 203,997 October 1975
TITLE: A STUDY OF FRACTURE MECHANICS FOR GRAPHITIC MATERIALS
AUTHOR(S): A. Cull, H. Starrett
CONTRACT NO: F33615-73-C-5109
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: Lt. T. Hinnerichs (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The purpose of this research is to study the fracture behavior of graphitic materials by the application and development of the techniques of fracture mechanics. Two materials are involved: ATJ-S (WS) graphite and MOD 3a carbon composite. Both compliance calibration and theoretical K-solutions were used to determine the fracture toughness and the stress intensity factor for ATJ-S (WS). The calculations are based on the maximum load and the initial compliance of the "load/load line deflection" curves of compact, fracture toughness specimens. A preliminary K-model for the T/S test was developed from a known solution by an experimental procedure. It was used to evaluate data collected from tests on slit, T/S specimens. The stress intensity factor value so determined is in general agreement with that of the fracture toughness tests.

REPORT NO: AFML-TR-75-136 AD A 018 159
ACCESS NO: 204,031 September 1975
TITLE: MECHANICAL PROPERTY DATA FOR ALUMINUM ALLOY 2419-T851 PLATE

AUTHOR(S): J. Ruschau
CONTRACT NO: F33615-74-C-5024
CONTRACTOR: University of Dayton
PROJECT MONITOR: D. Watson (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Tensile properties, fracture toughness, fatigue, fatigue crack growth, and stress corrosion properties for aluminum alloy/temper 2419-T851 two-inch-thick-plate were determined. The material was obtained from the Aluminum Company of America. Material property comparisons were then drawn between data developed from a single plate of the test alloy and aluminum alloy 2219 plate in the T851 heat treat condition. Material property comparisons indicate the two alloys possess very similar tensile properties, comparable fatigue crack growth rate properties, and similar fracture toughness properties. Notched (K_t=3.0) fatigue results for alloy 2419 coincide with those found for alloy 2219, while smooth fatigue results for 2419 were superior to 2219. Aluminum alloy 2419-T851 also demonstrated excellent resistance to stress corrosion cracking.

REPORT NO: AFML-TR-75-137 AD A 019 412
ACCESS NO: 204,109 September 1975
TITLE: THE STUDY OF THE EFFECT OF SHOCK INTERACTION ON AXISYMMETRIC CONCAVE CONIC SHAPES IN HYPERSONIC FLOW
AUTHOR(S): B. Richards, M. Kenworthy
CONTRACT NO: AFOSR-72-2227
CONTRACTOR: von Karman Institute for Fluid Dynamics
PROJECT MONITOR: Capt. G. Jumper, Capt. E. Heinonen (AFML/MXS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Heat transfer and pressure distributions have been measured on three concave biconic configurations in the von Karman Institute Longshot free **piston** wind tunnel at M=15 and 20. The test flow parameters achieved closely simulate aerodynamic re-entry conditions. Information derived from the measurements and also single spark and high speed cone schlieren flow visualization photographs enabled a qualitative description of the complicated two-shock steady flow system to be made and to explain the reason for the very high pressures and heat transfer rates measured on the concave surface. The effect of changing tip geometry, surface roughness, model incidence, and flow conditions on the interaction is examined experimentally.

REPORT NO: AFML-TR-75-138 AD A 019 781
ACCESS NO: 204,113 September 1975
TITLE: A STUDY OF THE UNSTEADY FLOW OVER CONCAVE CONIC MODELS AT MACH 15
AUTHOR(S): M. Kenworthy, B. Richards
CONTRACT NO: AFOSR-72-2227
CONTRACTOR: von Karman Institute for Fluid Dynamics
PROJECT MONITOR: Capt. G. Jumper, Capt. E. Heinonen (AFML/MXS)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: Pressure measurements and high speed cone schlieren photography have been used to study the unsteady flow behavior of the Mach 15 and 20 flow over families of concave conic model shapes. The test flow parameters achieved closely simulate aerodynamic reentry conditions. The unsteady flow behavior was found to resemble that found on certain configurations of spike cones. The shape of the concave surface and the Reynolds number were found to be important parameters controlling the type of instability. Further test programs are considered necessary to understand the flow processes and to define the boundaries of the instabilities.

REPORT NO: AFML-TR-75-139 AD A 018 805
ACCESS NO: 203,628 September 1975
TITLE: BOUNDARY LAYER TRANSITION ON BLUNT BODIES IN HYPERSONIC FLOW
AUTHOR(S): B. Richards
CONTRACT NO: AFOSR-72-2227
CONTRACTOR: von Karman Institute for Fluid Dynamics
PROJECT MONITOR: Capt. G. Jumper, Capt. E. Heinonen (AFML/MXS)
DIST. STATEMENT: Approved for public release; distributio unlimited.

ABSTRACT: Heat transfer and pressure distributions have been measured on a family of smooth and rough 50° - 8° biconic models in the M=15 to 20, Re/ft=2.0 X 10^6 flow simulating re-entry flow and achieved in the von Karman Institute's Longshot facility. The test conditions were selected to generate boundary layer transition data on these models. The heat transfer measurements agreed reasonably well with reference enthalpy prediction methods except for 0.004-inch mean element height wall roughness generated turbulent boundary layer cases when 35 per cent higher values than theory were measured. Transition occurred on the 50° half angle cone forebody in the region of $270 < Re_o < 400$ or $10^5 < Re_s < 2.5 \times 10^5$ for smooth surfaced models and $170 < Re_o < 300$ and $4 \times 10^4 < Re_s < 10^5$ for rough surfaced models. The Reynolds number range of the roughness height k on the rough models was $83 < Re_k < 500$.

REPORT NO: AFML-TR-75-158
ACCESS NO: 203,983 August 1975
TITLE: ADHESIVE BONDED AEROSPACE STRUCTURES STANDARDIZED REPAIR HANDBOOK
AUTHOR(S): J. McCarthy, R. Horton, et al.
CONTRACT NO: F33615-73-C-5171
CONTRACTOR: Boeing Commercial Airplane Co.
PROJECT MONITOR: W. Scardino (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: This report covers the second phase of a five-phase program to develop a standardized handbook for the repair of bonded aircraft structure. Tasks included the standardization of small repairs that are now covered by the various aircraft technical orders as well as general instructions for large repair work, including component rebuilding. Work completed in Phase II included the selection of standard procedures for small area repairs. Considerable progress was made in evaluating adhesives and surface preparation methods for bond strength and durability. At the conclusion of Phase II, a workshop was held at Dayton with military repair depot personnel and industry representatives. Inputs on key program items were received, which will establish direction for future program tasks.

AFML/MX

REPORT NO: AFML-TR-75-159 MCIC-HB-06
ACCESS NO: REF 263 December 1975
TITLE: SEM/TEM FRACTOGRAPHY HANDBOOK
AUTHOR(S): G. Pittinato, et al.
CONTRACT NO: F33615-74-C-5004
CONTRACTOR: McDonnell Douglas Astronautics Co.
PROJECT MONITOR: R. Henderson (AFML/MXA)
PROJECT NO: 7381
TASK NO: 738103
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: The SEM/TEM Electron Fractography Handbook was prepared with the primary intent of assisting in service failure analyses. The handbook consists of three separate sections. Section I describes the basic techniques used in handling and preparing specimens for electron fractography. Only those techniques that are routinely used in fracture surface analyses are discussed. In Section II of the handbook, the fracture surface characteristics and mechanisms associated with the different fracture modes are examined and illustrated. A discussion is given on the four principal fracture modes: dimple rupture, cleavage, fatigue, and decohesive rupture. Representative SEM and TEM fractographs depicting these fracture modes are also included in this section. Section III contains SEM and TEM electron fractographs of numerous alloys that were fractured under controlled conditions. This atlas of electron fractographs is organized by alloy type, and within each alloy subsection, by the specific test conditions that produced the fracture. Each test condition is introduced by a data page that contains the material form, heat treatment, test conditions and results, a macrophotograph showing the fracture surface features. On subsequent pages, SEM and TEM fractographs showing prominent fracture features are presented. For all of the alloys, a reference microstructure is included with the respective smooth tensile data.

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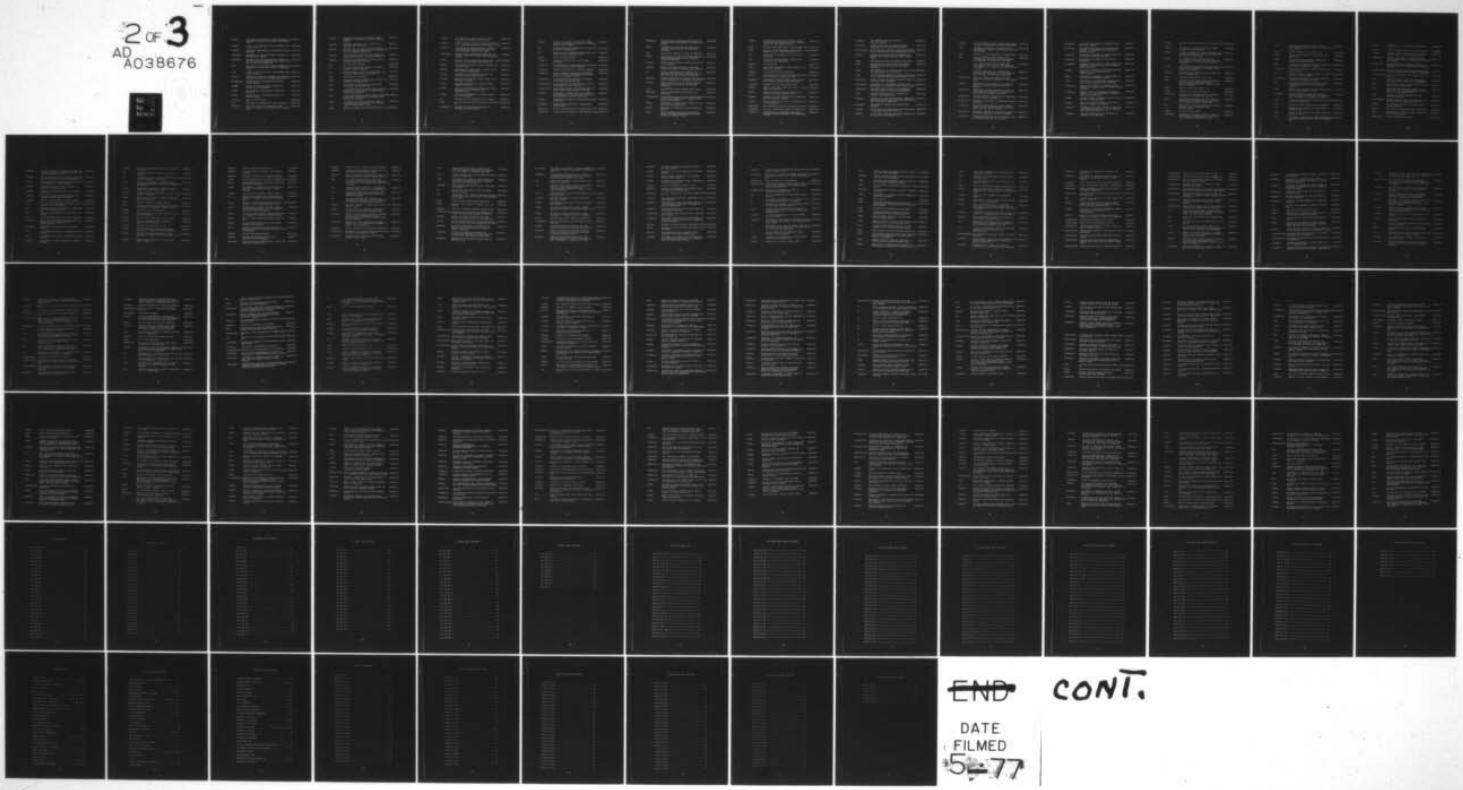
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MATRIX	ADVANCED ABLATIVE HEATSHIELDS FOR REENTRY MISSILES PT I LOW RECESSION/HIGH STRENGTH PIQ MATRIX FABRICATION STUDY	204009/052
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MECHANICAL	MICROSTRUCTURE MECHANICAL PROPERTY RELATIONSHIP IN SUPERALLOYS	204114/019
MECHANICAL	DEVELOPMENT OF ENGINEERING DATA ON THE MECHANICAL AND PHYSICAL PROPERTIES OF ADVANCED COMPOSITE MATERIALS	203772/067
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MILITARY	PROCEEDINGS OF THE 1974 TRISERVICE CORROSION OF MILITARY EQUIPMENT CONFERENCE 29-31 OCTOBER 1974 VOL II SESSION IV THROUGH VII	204110/07?
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MOLECULAR	MOLECULAR TAILORING OF FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS TO LOWER GLASS TRANSITION TEMPERATURES	204008/054
MOLECULAR	SYNTHESIS OF HIGH MOLECULAR WEIGHT PARAPHENYLENE PBI	203337/048
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NDI	EXPLORATORY DEVELOPMENT ON THE FEASIBILITY AND RECOMMENDATION FOR NDI OF IR WINDOWS	203345/022
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NONLINEAR	ADAPTIVE NONLINEAR SIGNAL PROCESSING FOR CHARACTERIZATION OF ULTRASONIC NDE WAVEFORMS TASK I INFERENCE OF FLATBOTTOM HOLE SIZE	203736/012
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OIL	DEVELOPMENT OF A GAS TURBINE ENGINE OIL FOR BULK OIL TEMPERATURES OF -40 TO 465 F	203680/051
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PBI	SYNTHESIS OF HIGH MOLECULAR WEIGHT PARAPHENYLENE PBI	203337/048
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PH	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/038
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PHYSICAL	DEVELOPMENT OF ENGINEERING DATA ON THE MECHANICAL AND PHYSICAL PROPERTIES OF ADVANCED COMPOSITE MATERIALS	203772/057
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PITCH	GRAPHITE FIBERS FROM PITCH PT II	203205/045
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PROTECTIVE-ANTI	PROTECTIVE-ANTIREFLECTIVE THIN FILMS FOR POLYCRYSTALLINE ZINC SELENIDE AND ALKALI HALIDE LASER WINDOWS	203173/025
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PT	ADVANCED PROTECTIVE MATERIALS FOR REENTRY MISSILE NOSETIPS PT I THREE-DIMENSIONAL REINFORCED CARBON/PLASTIC COMPOSITES	203826/058
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REINFORCED	ADVANCED REENTRY MISSILE HEATSHIELD MATERIALS PART III: HIGH STRAIN/STRENGTH FIBER MULTIDIRECTIONAL REINFORCED THERMALLY STABLE MATRIX COMPONENTS	203294/043
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RELIABILITY	RELIABILITY AND RISK ASSESSMENT METHODS AND REDUNDANT STRUCTURES	204096/003
RELIABILITY	RELIABILITY ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON PROBALISTIC INTERPRETATION OF THE SCATTER FACTOR	203804/005
RENE'	LOW CYCLE FATIGUE CRACK INITIATION STUDY IN RENE' 95	204036/011
REPAIR	MANUFACTURING METHODS FOR ENGINE BLADE REPAIR	201540/034
REPAIR	ADHESIVE BONDED AEROSPACE STRUCTURES STANDARDIZED REPAIR HANDBOOK	203983/075
REQUIREMENT	IMPROVED INSULATOR MATERIALS REQUIREMENT PROGRAM	203389/065

RESISTANCE	PROGRAM TO IMPROVE THE FRACTURE TOUGHNESS AND FATIGUE RESISTANCE OF ALUMINUM SHEET AND PLATE FOR AIRCRAFT APPLICATIONS	202045/004
RESISTANCE	MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES PART II	203894/048
RESISTANT	HIGH TEMPERATURES STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMERS COATINGS DEVELOPMENT	203793/057
RESISTANT	DEVELOPMENT OF CORROSION RESISTANT SURFACE TREATMENTS FOR ALUMINUM ALLOYS FOR SPOT-WELD BONDING	204038/058
RESISTANT	THERMAL FLASH RESISTANT IR SUPPRESSION COATINGS FOR ADVANCED AIRCRAFT SYSTEMS	203750/050
RESISTANT	POLYFUNCTIONAL FLUOROCARBON DERIVATIVES FOR CHEMICAL RESISTANT ELASTOMERS AND CROSSLINKING SYSTEMS	203535/050
RESISTANT	HIGH TEMPERATURE RESISTANT ELASTOMERS OR COMPLIANT POLYMERS	203297/042
RESORBABLE	EXPLORATORY DEVELOPMENT TO STUDY THE LONG-TERM EFFECTS OF RESORBABLE CERAMICS IN PRIMATES	204006/020
RESPONSE	THERMAL RESPONSE OF WOVEN AND KNITTED FABRICS IN JP-4 FUEL FIRE ENVIRONMENT	204134/057
RESPONSE	THERMOSTRUCTURAL RESPONSE OF CARBON/CARBON MATERIALS UNDER HIGH HEAT FLUX ENVIRONMENTS	203623/065
RESPONSE	AEROSPACE MATERIALS RESPONSE TO INTENSE THERMAL RADIATION	204108/060
REST-TIME	THE EFFECTS OF REST-TIME ON FATIGUE CRACK RETARDATION AND OBSERVATIONS	204059/015
RESULTS	F-15 COMPOSITE WING VOL II DEVELOPMENT AND TEST RESULTS	069613/002
RESULTS	F-15 COMPOSITE WING VOL I DEVELOPMENT AND TEST RESULTS	069613/001
RESULTS	RESULTS OF THE POLYMERIC FILMS SKYLAB D024 EXPERIMENT	203900/063

RESULTS	THE CARBON/CARBON ASSESSMENT PROGRAM 50 MW ABLATION TESTING AND RESULTS	204048/065
RETARDATION	A PRELIMINARY STUDY OF FATIGUE CRACK RETARDATION USING LASER INTERFEROMETRY TO MEASURE CRACK SURFACE DISPLACEMENTS	203807/005
RETARDATION	THE EFFECTS OF REST-TIME ON FATIGUE CRACK RETARDATION AND OBSERVATIONS	204059/015
RING	THE DEVELOPMENT AND DEMONSTRATION OF A HIGH TEMPERATURE RING TEST FACILITY	203415/066
RINGS	TWO-DIMENSIONAL STRESS INTENSITY FACTOR SOLUTIONS FOR RADIALLY CRACKED RINGS	204057/018
RISK	RELIABILITY AND RISK ASSESSMENT METHODS AND REDUNDANT STRUCTURES	204096/003
ROLE	THE ROLE OF TRANSIENT SPECTRUM AND DAMPING ANALYSIS IN ASSESSING THE STRENGTH OF POLYMERIC ADHESIVE METAL BONDING	203522/010
ROUGH	EX DEV OF HYPERSONIC HEAT TRANSFER AND THERMOCHEMICAL ABLATION OF ADV MATLS NOSETIP TEST DATA EVAL AND ROUGH WALL TRANSITION	203847/069
SCATTER	RELIABILITY ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON PROBALISTIC INTERPRETATION OF THE SCATTER FACTOR	203804/005
SCHOCK	THE STUDY OF THE EFFECT OF SCHOCK INTERACTION ON AXISYMMETRIC CONCAVE CONIC SHAPES IN HYPERSONIC FLOW	204109/074
SEALANT	DYNAMICS AND STATIC EVALUATION OF EXPERIMENTAL FUEL TANK SEALANT MATERIALS	203892/051
SEALANTS	HYBRID FLUOROSILICONES FOR AIRCRAFT FUEL TANK SEALANTS	203981/041
SEALANTS	HYDROFLUOROCARBON SEALANTS WITH IMPROVED LOW TEMPERATURE AND STRESS CORROSION PROPERTIES	203359/044
SEALS	LONG LIFE ELASTOMERIC AIRCRAFT HYDRAULIC SEALS	203217/044
SELENIDE	HARDENED CVD ZINC SELENIDE FOR FLIR WINDOWS	204037/030

SELENIDE	PROTECTIVE-ANTIREFLECTIVE THIN FILMS FOR POLYCRYSTALLINE ZINC SELENIDE AND ALKALI HALIDE LASER WINDOWS	203173/025
SEMICONDUCTORS	ROOM TEMPERATURE INJECTION LUMINESCENCE IN II-VI SEMICONDUCTORS	201818/023
SEMICONDUCTORS	CHEMICAL VAPOR DEPOSITION OF CHALCOGENIDE SEMICONDUCTORS	204098/029
SEMI-ORGANIC	SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS	203209/045
SEM/TEM	SEM/TEM FRACTOGRAPHY HANDBOOK	REF263/076
SENSITIVITY	PRACTICAL SENSITIVITY LIMITS OF PRODUCTION NONDESTRUCTIVE TESTING METHODS IN ALUMINUM AND STEEL	203852/007
SESSION	PROCEEDINGS OF THE 1974 TRISERVICE CORROSION OF MILITARY EQUIPMENT CONFERENCE 29-31 OCTOBER 1974 VOL II SESSION IV THROUGH VII	204110/070
SHAPE	ON THE SHAPE OF ERODING BODIES WITH APPLICATION TO BALLISTIC RANGE EROSION TESTS	204103/063
SHAPED	MANUFACTURING PROCESS FOR THE DENSIFICATION OF COMPLEX SHAPED WOVEN COMPOSITE PREFORMS	203848/037
SHAPES	THE STUDY OF THE EFFECT OF SCHOCK INTERACTION ON AXISYMMETRIC CONCAVE CONIC SHAPES IN HYPERSONIC FLOW	204109/074
SHATTERING	SHOCK LAYER SHATTERING OF WATER DROPS AND ICE CRYSTALS IN REENTRY	203843/059
SHEET	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008
SHEET	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008
SHEET	PROGRAM TO IMPROVE THE FRACTURE TOUGHNESS AND FATIGUE RESISTANCE OF ALUMINUM SHEET AND PLATE FOR AIRCRAFT APPLICATIONS	202045/004

SHIFTER	PHASE SHIFTER MANUFACTURING METHODS	203286/031
SHOCK	WATER DROP/BOW SHOCK INTERACTIONS	204094/018
SHOCK	SHOCK LAYER SHATTERING OF WATER DROPS AND ICE CRYSTALS IN REENTRY	203843/059
SIGNAL	ADAPTIVE NONLINEAR SIGNAL PROCESSING FOR CHARACTERIZATION OF ULTRASONIC NDE WAVEFORMS TASK I INFERENCE OF FLATBOTTOM HOLE SIZE	203736/012
SILICON	INFLUENCE OF IRON AND SILICON CONTENT ON THE TENSILE PROPERTIES OF 7X75 AND ZR-MOLDED 7X75 ALUMINUM PLATE	204007/019
SIM	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008
SINGLE	GROWTH OF DOPED AND UNDOPED SINGLE CRYSTAL LASER MATERIALS IN THE SYSTEM (MF2)XX(YF3)1-X	203787/027
SKYLAB	RESULTS OF THE POLYMERIC FILMS SKYLAB D024 EXPERIMENT	203900/063
SKYLAB	SKYLAB D024 THERMAL CONTROL COATINGS AND POLYMERIC FILMS EXPERIMENT	203823/059
SMXND1-XCO5	MAGNETIC RELAXATION EFFECTS IN PRCO5 AND SMXND1-XCO5 INDUCED BY HYDROGEN AND DEUTERIUM	203569/023
SOLID	EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS	203799/035
SOLIDIFICATION	AUTOMATED DIRECTIONAL SOLIDIFICATION OF SUPERALLOYS	204102/040
SOLIDS	DOASIS A COMPUTER CODE FOR THE DEFORMATION PLASTIC ORTHOTROPIC AXISYMMETRIC AND PLANE SOLUTION OF INELASTIC SOLIDS	204136/070
SOLUTION	DOASIS A COMPUTER CODE FOR THE DEFORMATION PLASTIC ORTHOTROPIC AXISYMMETRIC AND PLANE SOLUTION OF INELASTIC SOLIDS	204136/070
SOLUTIONS	TWO-DIMENSIONAL STRESS INTENSITY FACTOR SOLUTIONS FOR RADIALLY CRACKED RINGS	204057/018

SPACEFLIGHT	ML-101 THERMAL CONTROL COATING SPACEFLIGHT EXPERIMENT	204133/054
SPECIALTY	NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS	203883/050
SPECTRA	COMPUTER ANALYSIS OF THE MASS SPECTRA OF GAS MIXTURES	203356/047
SPECTRA	INFERRING MECHANICAL RELAXATION SPECTRA AN ILL-POSED PROBLEM	203851/051
SPECTRAL	FLUORIDE WINDOW MATERIALS FOR USE AS LASER WINDOWS IN THE 2 TO 6 UM SPECTRAL REGION	203898/028
SPECTRUM	THE ROLE OF TRANSIENT SPECTRUM AND DAMPING ANALYSIS IN ASSESSING THE STRENGTH OF POLYMERIC ADHESIVE METAL BONDING	203522/010
SPINEL	MANUFACTURING METHODS FOR SPINEL FERRITES FOR USE IN MICROWAVE TUBES	203375/032
SPLICE	DEVELOPMENT OF IMPROVED CORE SPLICE ADHESIVES	204005/056
SPOT-WELD	DEVELOPMENT OF CORROSION RESISTANT SURFACE TREATMENTS FOR ALUMINUM ALLOYS FOR SPOT-WELD BONDING	204038/058
STABLE	HIGH TEMPERATURES STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMERS COATINGS DEVELOPMENT	203793/057
STABLE	SYNTHESIS OF THERMALLY STABLE POLYMERS	203982/050
STABLE	ADVANCED REENTRY MISSILE HEATSHIELD MATERIALS PART III: HIGH STRAIN/STRENGTH FIBER MULTIDIRECTIONAL REINFORCED THERMALLY STABLE MATRIX COMPONENTS	203294/043
STABLE	POLYMER STRUCTURES AND PROPERTIES PART IV THERMALLY STABLE POLYMERS	203895/041
STABLE	HIGH TEMPERATURE THERMALLY STABLE GREASES	203409/042
STANDARDIZED	ADHESIVE BONDED AEROSPACE STRUCTURES STANDARDIZED REPAIR HANDBOOK	203983/075
STAT	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008

STATIC	STATIC AND DYNAMIC FRACTURE PROPERTIES FOR ALUMINUM ALLOY 7475-T651 AND T7351	203783/069
STATIC	DYNAMICS AND STATIC EVALUATION OF EXPERIMENTAL FUEL TANK SEALANT MATERIALS	203892/051
STEEL	PRACTICAL SENSITIVITY LIMITS OF PRODUCTION NONDESTRUCTIVE TESTING METHODS IN ALUMINUM AND STEEL	203852/007
STEEL	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008
STEEL	STRESS-CORROSION CRACKING OF METALLIC MATERIALS PT III HYDROGEN ENTRY AND EMBRITTLEMENT IN STEEL	203562/004
STEELS	RESEARCH TOWARD HIGH STRENGTH HIGH TOUGHNESS STEELS	204100/018
STRAIN	MECHANICAL PROPERTIES OF STRUCTURAL GRADES OF BERYLLIUM AT HIGH STRAIN RATES	204099/020
STRAIN	EFFECT OF PLASTIC PRESTRAIN ON THE TENSILE STRAIN TO FAILURE OF BERYLLIUM	203844/015
STRAIN	DYNAMIC COMPRESSIVE STRAIN RATE TESTS ON SEVERAL GRADES OF BERYLLIUM	203344/006
STRAIN	ANALYSIS OF HIGH STRAIN GRAPHITE	203438/055
STRAIN/STRENGTH	ADVANCED REENTRY MISSILE HEATSHIELD MATERIALS PART III: HIGH STRAIN/STRENGTH FIBER MULTIDIRECTIONAL REINFORCED THERMALLY STABLE MATRIX COMPONENTS	203294/043
STRENGTH	STRENGTH CHARACTERISTICS OF BORON ALUMINUM COMPOSITE SUBJECTED TO COMBINED STRESSES	203507/006
STRENGTH	THE ROLE OF TRANSIENT SPECTRUM AND DAMPING ANALYSIS IN ASSESSING THE STRENGTH OF POLYMERIC ADHESIVE METAL BONDING	203522/010
STRENGTH	NOTCH TENSILE STRENGTH OF ADVANCED STRUCTURAL GRADES OF BERYLLIUM	203675/007
STRENGTH	RESEARCH TOWARD HIGH STRENGTH HIGH TOUGHNESS STEELS	204100/018

STRENGTH	ADVANCED ABLATIVE HEATSHIELDS FOR REENTRY MISSILES PT I LOW RECESSION/HIGH STRENGTH PIQ MATRIX FABRICATION STUDY	204009/052
STRESS	TWO-DIMENSIONAL STRESS INTENSITY FACTOR SOLUTIONS FOR RADIALLY CRACKED RINGS	204057/018
STRESS	A STRESS INTENSITY FACTOR CALIBRATION FOR CORNER FLAWS AT AN OPEN HOLE	203819/010
STRESS	DETERMINATION OF STRESS INTENSITY FACTOR FOR COLD-WORKED FASTENER HOLES IN 7075 ALUMINUM USING THE CRACK GROWTH METHOD	203820/010
STRESS	REENTRY VEHICLE NOSETIP STRESS ANALYSIS	204125/072
STRESS	MATERIALS AND APPROACHES FOR IMPROVED STRESS CORROSION INHIBITIVE COATINGS	203218/043
STRESS	HYDROFLUOROCARBON SEALANTS WITH IMPROVED LOW TEMPERATURE AND STRESS CORROSION PROPERTIES	203359/044
STRESSES	STRENGTH CHARACTERISTICS OF BORON ALUMINUM COMPOSITE SUBJECTED TO COMBINED STRESSES	203507/006
STRESSES	STRESSES IN AN ADHESIVE BONDED COMPOSITE-TO-METAL ASSEMBLY	203773/068
STRESS-CORROSIO	STRESS-CORROSION CRACKING OF METALLIC MATERIALS PT III HYDROGEN ENTRY AND EMBRITTLEMENT IN STEEL	203562/004
STRUCTURAL	MECHANICAL PROPERTIES OF STRUCTURAL GRADES OF BERYLLIUM AT HIGH STRAIN RATES	204099/020
STRUCTURAL	NOTCH TENSILE STRENGTH OF ADVANCED STRUCTURAL GRADES OF BERYLLIUM	203675/007
STRUCTURAL	RESEARCH ON DEEP HARDENING TITANIUM ALLOY FOR LARGE AIRFRAME STRUCTURAL MEMBERS	203925/013
STRUCTURAL	ENGINEERING DATA ON NEW AEROSPACE STRUCTURAL MATERIALS	203980/072
STRUCTURE	MANUFACTURING METHODS FOR FABRICATION AND ASSEMBLY OF ADVANCED COMPOSITE PRIMARY AIRCRAFT STRUCTURE	202878/038

STRUCTURE	MANUFACTURING METHODS FOR THERMAL EXPANSION MOLDING OF ADVANCED COMPOSITES AIRCRAFT STRUCTURE	203128/038
STRUCTURES	COMPLEMENTARY BIPOLAR TRANSISTOR STRUCTURES	203995/031
STRUCTURES	LOW-TEMPERATURE LARGE-AREA BRAZING OF TITANIUM STRUCTURES	201790/014
STRUCTURES	ADVANCED DEVELOPMENT ON VULNERABILITY/SURVIVABILITY OF ADVANCED COMPOSITE STRUCTURES	069611/002
STRUCTURES	LIFE ASSURANCE OF COMPOSITE STRUCTURES VOL I MOISTURE EFFECTS	203825/002
STRUCTURES	RELIABILITY ASSESSMENT OF AIRCRAFT STRUCTURES BASED ON PROBALISTIC INTERPRETATION OF THE SCATTER FACTOR	203804/005
STRUCTURES	RELIABILITY AND RISK ASSESSMENT METHODS AND REDUNDANT STRUCTURES	204096/003
STRUCTURES	ADHESIVE BONDED AEROSPACE STRUCTURES STANDARDIZED REPAIR HANDBOOK	203983/075
STRUCTURES	SUPERPLASTIC FORMING OF TITANIUM STRUCTURES	203854/037
STRUCTURES	POLYMER STRUCTURES AND PROPERTIES PART IV THERMALLY STABLE POLYMERS	203995/041
SUBJECTED	STRENGTH CHARACTERISTICS OF BORON ALUMINUM COMPOSITE SUBJECTED TO COMBINED STRESSES	203507/006
SUBSONIC	HIGH TEMPERATURES STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMERS COATINGS DEVELOPMENT	203793/057
SULFUR-DOPED	ZINC ION IMPLANTATION OF SULFUR-DOPED GALLIUM PHOSPHIDE	203626/029
SUPERALLOYS	MICROSTRUCTURE MECHANICAL PROPERTY RELATIONSHIP IN SUPERALLOYS	204114/019
SUPERALLOYS	AUTOMATED DIRECTIONAL SOLIDIFICATION OF SUPERALLOYS	204102/040
SUPERCONDUCTING	EXPERIMENTAL HYSTERETIC LOSS FOR A SERIES OF SUPERCONDUCTING FILAMENTARY NBTI WIRES AND A FIELD DEPENDENT CRITICAL STATE MODEL	204035/024

SUPERCONDUCTORS	AC LOSS AS A FUNCTION OF CURRENT AND EXTERNAL MAGNETIC FIELD IN COMMERCIAL NBTI SUPERCONDUCTORS	203798/026
SUPERPLASTIC	SUPERPLASTIC FORMING OF TITANIUM STRUCTURES	203854/037
SUPPRESSION	THERMAL FLASH RESISTANT IR SUPPRESSION COATINGS FOR ADVANCED AIRCRAFT SYSTEMS	203750/050
SURFACE	A PRELIMINARY STUDY OF FATIGUE CRACK RETARDATION USING LASER INTERFEROMETRY TO MEASURE CRACK SURFACE DISPLACEMENTS	203807/005
SURFACE	DEVELOPMENT OF CORROSION RESISTANT SURFACE TREATMENTS FOR ALUMINUM ALLOYS FOR SPOT-WELD BONDING	204038/058
SURFACE	SURFACE ANALYSIS OF 2024 AND 7075 ALUMINUM ALLOYS AFTER CONDITIONING BY CHEMICALTREATMENTS	204107/062
SWAGING	PLANETARY BALL SWAGING OF WELDED TITANIUM ALLOY TUBING	067738/031
SYNTHESIS	SYNTHESIS OF THERMALLY STABLE POLYMERS	203982/060
SYNTHESIS	SYNTHESIS OF PERFLUOROALIPHATIC ETHER MONOMERS	203901/062
SYNTHESIS	SYNTHESIS OF HIGH MOLECULAR WEIGHT PARAPHENYLENE PBI	203337/048
SYNTHESIS	SYNTHESIS OF QUINOZALINE POLYMERS BY INTERMOLECULAR CYCLIZATION	203882/053
SYNTHESIS	SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS	203209/045
SYNTHESIS	SYNTHESIS OF OXYARYLENE BBB POLYMERS	203897/053
TAILORING	MOLECULAR TAILORING OF FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS TO LOWER GLASS TRANSITION TEMPERATURES	204008/054
TANK	HYBRID FLUOROSILICONES FOR AIRCRAFT FUEL TANK SEALANTS	203981/041
TANK	DYNAMICS AND STATIC EVALUATION OF EXPERIMENTAL FUEL TANK SEALANT MATERIALS	203892/051

TASK	ADAPTIVE NONLINEAR SIGNAL PROCESSING FOR CHARACTERIZATION OF ULTRASONIC NDE WAVEFORMS TASK I INFERENCE OF FLATBOTTOM HOLE SIZE	203736/012
TELLURIDE	CHEMICAL VAPOR DEPOSITION OF CADMIUM TELLURIDE	203682/028
TEMPERATURE	ROOM TEMPERATURE INJECTION LUMINESCENCE IN II-VI SEMICONDUCTORS	201818/023
TEMPERATURE	DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES	204032/061
TEMPERATURE	THE DEVELOPMENT AND DEMONSTRATION OF A HIGH TEMPERATURE RING TEST FACILITY	203415/055
TEMPERATURE	DEVELOPMENT OF HIGH TEMPERATURE FUNCTIONAL FLUIDS	203295/043
TEMPERATURE	HIGH TEMPERATURE THERMALLY STABLE GREASES	203409/042
TEMPERATURE	HYDROFLUOROCARBON SEALANTS WITH IMPROVED LOW TEMPERATURE AND STRESS CORROSION PROPERTIES	203359/044
TEMPERATURES	MOLECULAR TAILORING OF FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS TO LOWER GLASS TRANSITION TEMPERATURES	204008/054
TEMPERATURES	HIGH TEMPERATURES STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMERS COATINGS DEVELOPMENT	203793/057
TEMPERATURES	DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES	203255/047
TEMPERATURES	DEVELOPMENT OF A GAS TURBINE ENGINE OIL FOR BULK OIL TEMPERATURES OF -40 TO 465 F	203680/051
TENSILE	INFLUENCE OF IRON AND SILICON CONTENT ON THE TENSILE PROPERTIES OF 7X75 AND ZR-MOLDED 7X75 ALUMINUM PLATE	204007/019
TENSILE	EFFECT OF PLASTIC PRESTRAIN ON THE TENSILE STRAIN TO FAILURE OF BERYLLIUM	203844/015
TENSILE	NOTCH TENSILE STRENGTH OF ADVANCED STRUCTURAL GRADES OF BERYLLIUM	203675/007
TENSILE	BIAXIAL TENSILE FRACTURE OF ATJ-S GRAPHITE	203720/066

THERMAL	THERMAL ELECTRICAL AND PHYSICAL PROPERTY MEASUREMENTS OF LASER WINDOW MATERIALS	201819/026
THERMAL	THERMAL RESPONSE OF WOVEN AND KNITTED FABRICS IN JP-4 FUEL FIRE ENVIRONMENT	204134/057
THERMAL	EXPLORATORY DEVELOPMENT TO OBTAIN THERMAL AND MECHANICAL CHARACTERIZATION DATA ON ADVANCED CARBON INSULATION	203760/071
THERMAL	SKYLAB D024 THERMAL CONTROL COATINGS AND POLYMERIC FILMS EXPERIMENT	203823/059
THERMAL	AEROSPACE MATERIALS RESPONSE TO INTENSE THERMAL RADIATION	204108/060
THERMAL	ML-101 THERMAL CONTROL COATING SPACEFLIGHT EXPERIMENT	204133/054
THERMAL	MANUFACTURING METHODS FOR THERMAL EXPANSION MOLDING OF ADVANCED COMPOSITES AIRCRAFT STRUCTURE	203128/038
THERMAL	THERMAL FLASH RESISTANT IR SUPPRESSION COATINGS FOR ADVANCED AIRCRAFT SYSTEMS	203750/050
THERMAL	INVESTIGATION OF CONTAMINATION EFFECTS OF THERMAL CONTROL	203574/049
THERMALLY	SYNTHESIS OF THERMALLY STABLE POLYMERS	203982/060
THERMALLY	POLYMER STRUCTURES AND PROPERTIES PART IV THERMALLY STABLE POLYMERS	203895/041
THERMALLY	ADVANCED REENTRY MISSILE HEATSHIELD MATERIALS PART III: HIGH STRAIN/STRENGTH FIBER MULTIDIRECTIONAL REINFORCED THERMALLY STABLE MATRIX COMPONENTS	203294/043
THERMALLY	HIGH TEMPERATURE THERMALLY STABLE GREASES	203409/042

THERMOCHEMICAL	EX DEV OF HYPERSONIC HEAT TRANSFER AND THERMOCHEMICAL ABLATION OF ADV MATLS NOSETIP TEST DATA EVAL AND ROUGH WALL TRANSITION	203847/059
THERMOCHEMICAL	THERMOCHEMICAL ABLATION OF AROMATIC/HETEROCYCLIC POLYMERIC COMPOSITES PART III MATERIAL ELEMENTAL COMPOSITION PERFORMANCE OPTIMIZATION	203434/042
THERMOMECHANICA	EXPLORATORY DEVELOPMENT OF HYPERSONIC HEAT TRANSFER AND THERMOMECHANICAL ABLATION OF ADVANCED MATERIALS	203847/070
THERMOSTRUCTURA	THERMOSTRUCTURAL RESPONSE OF CARBON/CARBON MATERIALS UNDER HIGH HEAT FLUX ENVIRONMENTS	203623/065
THERMO-AGING	DATA ACQUISITION AND ANALYSIS OF LONG-TERM THERMO-AGING DEGRADATION DATA	203762/001
THIN	PROTECTIVE-ANTIREFLECTIVE THIN FILMS FOR POLYCRYSTALLINE ZINC SELENIDE AND ALKALI HALIDE LASER WINDOWS	203173/025
TITANIUM	PLANETARY BALL SWAGING OF WELDED TITANIUM ALLOY TUBING	067738/031
TITANIUM	GRAIN REFINEMENT OF TITANIUM ALLOYS	203457/008
TITANIUM	FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS	202433/004
TITANIUM	LOW-TEMPERATURE LARGE-AREA BRAZING OF TITANIUM STRUCTURES	201790/014
TITANIUM	BORON ALUMINUM TITANIUM HYBRID COMPOSITES	203824/007
TITANIUM	NONDESTRUCTIVE TESTING OF DIFFUSION BONDED TITANIUM ALLOYS FOR ENGINE AND AIRFRAME COMPONENTS	203842/006
TITANIUM	OXIDATION BEHAVIOR OF TITANIUM ALLOYS UNDER HIGH HEATING RATES	203776/008
TITANIUM	DEVELOPMENT OF HOT ISOSTATIC PRESSING TECHNIQUES FOR PRODUCING HIGH QUALITY BILLET FROM TITANIUM ALLOY POWDER	203881/012
TITANIUM	FRACTURE TOUGHNESS AND AGING BEHAVIOR OF ALPHA-BETA TITANIUM ALLOYS	204092/017

TITANIUM	CRACK ARREST IN TITANIUM	203886/017
TITANIUM	CRACK PROPAGATION CHARACTERISTICS IN THREE DEEP HARDENABLE TITANIUM ALLOYS	204112/016
TITANIUM	EXPLORATORY DEVELOPMENT OF IMPROVED CUTTING TOOLS FOR TITANIUM	204104/016
TITANIUM	EFFECT OF OMEGA PHASE ON SELECTED PROPERTIES OF BETA III TITANIUM ALLOY	203845/013
TITANIUM	RESEARCH ON DEEP HARDENING TITANIUM ALLOY FOR LARGE AIRFRAME STRUCTURAL MEMBERS	203925/013
TITANIUM	PPQ ADHESIVES FOR LARGE AREA BONDING OF TITANIUM ALLOYS	204106/062
TITANIUM	NONCONSUMABLE MELTING OF TITANIUM	200710/037
TITANIUM	SUPERPLASTIC FORMING OF TITANIUM STRUCTURES	203854/037
TI-6AL-4V	HOT ISOSTATIC PRESSING OF TI-6AL-4V POWDER FORGING PREFORMS	202196/034
TI-6AL-4V	EX OF STAT FATIGUE CHARA OF 0.063-INCH MILL-ANNEALED TI-6AL-4V SHEET AND 0.050-INCH HEAT TREATED 17-7 PH STEEL SHEET UNDER SIM F BY F LOADING	202168/008
TI-6AL-6V-2SN	THE EVALUATION OF TI-6AL-6V-2SN PRE-ALLOYED POWDER PROCESSING	203889/071
TOOLS	EXPLORATORY DEVELOPMENT OF IMPROVED CUTTING TOOLS FOR TITANIUM	204104/016
TOP	SOME GENERAL PROGRAMS FOR DESK TOP COMPUTERS	203811/009
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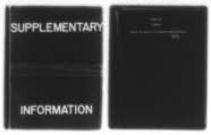
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CORRECTION

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