AFML-TR-75-123

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# ABSTRACTS OF AF MATERIALS LABORATORY REPORTS

*OPERATIONS OFFICE*

SEPTEMBER 1975

TECHNICAL REPORT AFML-TR-75-123
FINAL REPORT FOR PERIOD JANUARY 1974 – DECEMBER 1974

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AIR FORCE MATERIALS LABORATORY
**AIR FORCE WRIGHT AERONAUTICAL LABORATORIES**
**Air Force Systems Command**
**Wright-Patterson Air Force Base, Ohio 45433**

1473

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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 order number 73810328. Mr. Dennis Wisnosky (AFML/DO) 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.

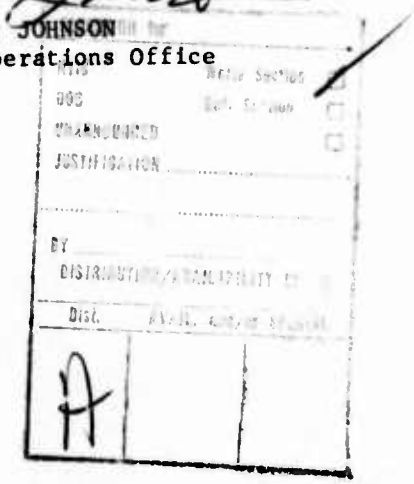
Dennis E. Wisnosky

DENNIS E. WISNOSKY
Project Monitor

FOR THE COMMANDER

Warren P. Johnson

WARREN P. JOHNSON
Chief, Operations Office

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Technical reports published by the Air Force Materials Laboratory during the period 1 January 1974 - 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 AMIC accession numbers are given. Reports on research conducted by the Air Force Materials Laboratory personnel as well as that conducted on contract are included.

(continued)

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A number of indices are included in the report: subject (KWOC), AD accession number, AFML report number, contract number, contractor, author, and AFML project monitor.

# FOREWORD

Technical reports published by the Air Force Materials Laboratory during the period 1 January 1974 - 31 December 1974 are abstracted herein. Reports on research conducted by Air Force Materials Laboratory personnel as well as that 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-74-95 AD 784 788
ACCESS NO: 202,855 June 1974
TITLE: ABSTRACTS OF ACTIVE CONTRACTS, AIR FORCE MATERIALS LABORATORY
AUTHOR(S): N/A
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: E. Dugger (AFML/DO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Abstracts of Air Force Materials Laboratory Contracts that were active on 5 February 1974 are reported. The abstracts are indexed by contractor, contract number, and work unit number. 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-74-106
ACCESS NO: R-182 July 1974
TITLE: ABSTRACTS OF AF MATERIALS LABORATORY REPORTS, JANUARY 1973 - DECEMBER 1973
AUTHOR(S): N/A
CONTRACT NO: N/A
CONTRACTOR: internal
PROJECT MONITOR: E. Dugger (AFML/DO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Technical reports published by the Air Force Materials Laboratory during the period 1 January 1973 - 31 December 1973 are abstracted herein. They are presented in groups corresponding to the divisions of the Laboratory. In addition to the abstract text, the report number, investigator, AFML project monitor, contractor, contract number, AFML project/task number, report date, and AMIC accession numbers are given. Reports on research conducted by the Air Force Materials Laboratory personnel as well as that conducted on contract are included. A number of indices are included in the report: subject (KWOC), AD accession number, AFML report number, contract number, contractor, investigator, and AFML project monitor.

REPORT NO: AFML-TR-74-212 AD A 004 301
ACCESS NO: 203,195 August 1974
TITLE: THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT
AUTHOR(S): J.F. March and F.L. Scheffler
CONTRACT NO: F33615-71-C-1069
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: E. Dugger (AFML/DO)

AFML/DO

PROJECT NO: 7381
TASK NO: 738103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: In March 1973 it was decided to offer on-line computer literature searching services to research personnel of the Air Force Materials Laboratory. Initially, the data base of technical reports of the National Technical Information Service (NTIS) and the data base of chemical and chemical engineering journal literature available through the Chemical Abstracts Service were offered. The "marketing" of the new on-line searching capability to Materials Laboratory research personnel was a more significant problem than we anticipated. Demonstration conferences were held and memorandums distributed, but our most successful marketing was accomplished through informal contacts. During the one and one-half years of providing on-line literature searching services, the program has grown in terms of the number of individuals using the on-line services and the frequency with which on-line literature search requests are made. It has also grown significantly in terms of additional on-line data bases which have been acquired and made available to AFML personnel.

ADVANCED DEVELOPMENT DIVISION (AFML/LC)

REPORT NO: AFML-TR-73-204 AD 916 695L
ACCESS NO: 79,613 September 1973
TITLE: CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS
AUTHOR(S): L.R. Hall, R. W. Finger, W.F. Spurr
CONTRACT NO: F33615-71-C-1687
CONTRACTOR: Boeing Aerospace Company
PROJECT MONITOR: N. Tupper (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This experimental program was undertaken to obtain information on stress corrosion cracking and corrosion fatigue crack growth in high strength metal alloys suitable for airframe components. In addition, tests were conducted to evaluate the effects of overloads and metallurgical factors on corrosion crack growth. The four principal alloys were 7075-T651 aluminum, 6Al-4V(ELI) beta annealed titanium, 6Al-4V recrystallized annealed (RA) titanium, and 9Ni-4Co-0.3 steel. A series of tests were undertaken to evaluate the effects on scc and corrosion fatigue cracking of variations in metallurgical characteristics imparted to Ti-6Al-4V RA alloy plate by various thermal cycles.

REPORT NO: AFML-TR-73-225, Volumes I and II AD 918 496L (Vol.I)
AD 918 497L (Vol.II)
ACCESS NO: 69,543 August 1971
TITLE: COMPOSITE STRUCTURE SAFELIFE PREDICTION
AUTHOR(S): E.R. Durchlaub, R.B. Freeman
CONTRACT NO: F33615-71-C-1604
CONTRACTOR: Boeing Company
PROJECT MONITOR: W. Johnston (AFML/LC)
PROJECT NO: 6169CW
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The excellent fatigue properties and inherent damage tolerance of composites offer a potential in safelife and fail-safety as attractive as the demonstrated weight savings. To use this inherent capability to achieve safelife and failsafe structures, the designer requires quantitative information and fracture mechanics theories similar to those now available for metals. Little such information now exists. This program will provide this information on boron-epoxy composites. The program is divided into five areas of endeavor, all aimed at obtaining the necessary experimental data on crack propagation and fracture toughness of boron-epoxy composites materials.

REPORT NO: AFML-TR-73-317
ACCESS NO: 202,863 January 1974
TITLE: INTERACTIVE PROGRAM IN DESIGN AND ANALYSIS OF COMPOSITE MATERIALS
AUTHOR(S): T. H. H. Pian
CONTRACT NO: F33615-70-C-1131
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: A. Davis (AFML/LC)

AFML/LC

PROJECT NO: 1193/6169 CW
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The report describes the results of three research areas: (1) development of analysis tools for composite plate and shell structures; (2) basic studies of interlaminar shear; (3) synthesis and design of adhesively bonded step joints. The university-industry-Air Force interaction and the educational accomplishments under this program are described. Finally, to indicate a significant impact of the present program, a brief description is given of another research program which deals with the analysis of laminated plates and shells of composite materials and is an extension of a preliminary study under the present program.

REPORT NO: AFML-TR-74-5 AD 918 604L
ACCESS NO: 300,167 January 1974
TITLE: ADVANCED COMPOSITE WING AND EMPENNAGE TO FUSELAGE ATTACHMENT
AUTHOR(S): W.H. Schaefer, R.E. Bender, D.R. Dunabar
CONTRACT NO: F33615-71-C-1587
CONTRACTOR: General Dynamics
PROJECT MONITOR: W. Schulz (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report summarizes an investigation of advanced composite materials for the specialized area of highly loaded fittings, particularly fittings in the area of wing and fuselage attachments on recent high performance aircraft. Such areas, currently in the domain of high-strength metals parts, offered a severe test for the capabilities of composite materials.

REPORT NO: AFML-TR-74-29 N74-30443 AD 779 830
ACCESS NO: 202,656 February 1974
TITLE: RELIABILITY ANALYSIS OF FATIGUE-SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION
AUTHOR(S): J.N. Yang, W.J. Trapp
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: W.J. Trapp (AFML/LC)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A reliability analysis of fatigue-sensitive structures, based on the application of random vibration theory, is presented. Operational service loads, composed of groundloads, ground-air-ground loads, and gust loads, are all random in nature. The fatigue process involved here consists of crack initiation, crack propagation and strength degradation. The time to crack initiation and the ultimate strength are random variables. After a fatigue crack is initiated, fracture mechanics is applied to predict crack propagation under random loading. While the fatigue crack is propagating, the residual strength of the structure decreases progressively, thus increasing the failure rate with time. When a fatigue crack is detected, the implicated component is either repaired or replaced, so that both the static and the fatigue

strength are renewed. Such a renewal process is taken into account in the present analysis. Finally, numerical examples are given to demonstrate effect of inspection and fleet size on the fleet reliability.

REPORT NO: AFML-TR-74-33 AD 919 165L
ACCESS NO: 300,282 March 1974
TITLE: ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA
AUTHOR(S): N. P. Freund
CONTRACT NO: F33615-72-C-2033
CONTRACTOR: Perkin-Elmer Corp.
PROJECT MONITOR: W.J. Schulz (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Results are reported on an investigation to evaluate the usefullness of selected graphite/epoxy composite structures for applications requiring precision tolerancing and dimensional control. Laminate composites in the double symmetric design were tested, as well as a honeycomb design having two singly symmetric faceplates bonded to an aluminum core. Non-destructive testing employing holography was conducted to determine micro-yielding and microcreep behavior. Optical processing methods were investigated, and mirrors with three types of reflector surfaces were fabricated. Environmental testing including thermal cycling, thermal stability, humidity/vacuum effects, and temporal stability was done on mirrors representing the various processing methods. Data, discussion of results and recommendations for applicable areas are given for the specific material and design types tested.

REPORT NO: AFML-TR-74-38 AD 918 294L
ACCESS NO: 200,703 July 1972
TITLE: ADVANCED DEVELOPMENT OF NOT-CRITICAL-TO-FLIGHT-SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES
AUTHOR(S): A.L. Scow
CONTRACT NO: F33615-72-C-1781
CONTRACTOR: Northrop Corp.
PROJECT MONITOR: R. Rapson (AFML/LC)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The Northrop F-5E and A-9A aircraft were selected as vehicles from which the NCTFS demonstration components will be considered. Prospective structural components from these vehicles were reviewed and four components typical of NCTFS control surfaces (F-5E leading edge flap and trailing edge flap, A-9A speed brake and rudder) were selected for detail study. At the conclusion of this study, the F-5E trailing edge flap and the A-9A rudder were selected as demonstration components, with Air Force Project Monitor concurrence. Preliminary conceptual studies for the components have been completed. Preliminary design of these components is currently in progress. In Task II, a panel simulating the size and fiber orientation of typical hardware was fabricated from AS/X-505 and cut into three sections. The sections were then cured by conventional autoclave, heated platen press and vacuum bag-oven cure processes and a comparison of the methods made.

AFML/LC

REPORT NO: AFML-TR-74-79 AD 921 654L
ACCESS NO: 202,991 May 1974
TITLE: COMPOSITE ENGINE CONCEPTUAL DESIGN
AUTHOR(S): G.S. Calvert
CONTRACT NO: F33615-73-C-5165
CONTRACTOR: Pratt and Whitney
PROJECT MONITOR: R. Tomashot/LC
PROJECT NO: 6169CW
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Advanced composites were studied for application in future turbofan engines for Air Force applications. The baseline engine for this study was the current F100 engine. Graphite-polyimide composites were evaluated as fan blades, fan stator and case assembly, and fan exhaust duct. A tantalum wire-reinforced ceramic composite was evaluated in a swirl combustor application. The remainder of the engine was reconfigured to maximize the benefits of the composites, and the resulting engine was estimated to be $177,000 less costly and 298 lb lighter than the baseline.

REPORT NO: AFML-TR-74-97 AD 922 712L
ACCESS NO: 203,024 June 1974
TITLE: ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA
AUTHOR(S): G.E. Pynchon
CONTRACT NO: F33615-72-C-1388
CONTRACTOR: General Dynamics
PROJECT MONITOR: R.L. Rapson, W.J. Schulz (AFML/LC)
PROJECT NO: 6169CW
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Engineering data appropriate to the use of selected graphite/epoxy composite materials in dimensionally critical space applications is presented. The thermal strain characteristics of a large number of material/layup configurations over the temperature range -320F to 250F were investigated. Additional data from the investigation of 2 systems, HM-S/X-30 and GY-70/X-904, is also included. The outgassing characteristics in a hard vacuum at temperatures to 150F were measured including identification of outgassing products by atomic mass number and the effect of outgassing on optical reflectors. Thermal conductivity data over the temperature range, the effect of moisture, and the effect of thermal cycling of composite substrate lightweight mirrors over selected temperature intervals between -320F and 250F are presented. Fabrication techniques are discussed as they relate to dimensional stability. The design and fabrication of a lightweight 12-in. diameter fully figured spherical mirror is discussed and the results of a test of the figure are presented.

AFML/LC

REPORT NO: AFML-TR-74-105 AD 922 975L
ACCESS NO. 203,049 May 1974
TITLE: COMPOSITE BOX BEAM OPTIMIZATION. VOLUME I. DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES
AUTHOR(S): P. Donohue
CONTRACT NO: F33615-71-C-1605
CONTRACTOR: Grumman Aerospace Corp.
PROJECT MONITOR: R. Rapson, W. Schulz (AFML/LC)
PROJECT NO: 698CW
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This program was undertaken to extend the design and manufacturing technological base developed for highly loaded wings fabricated of the boron/epoxy composite system and to demonstrate, with a representative component, a minimum weight savings in the order of 30% over a comparable baseline metal design. This volume reports the design engineering and manufacturing technologies associated with materials development, selection and design allowables, design and analysis philosophy, criteria and procedures; the results of configuration studies and selection from minimum weight and cost considerations; the final design of a demonstration component representative of a final wing design; and the associated manufacturing philosophies, development and procedures. Design tension, compression and shear strength, and average stiffness as well as strength of bolted and brazed joints, and thermal properties of the $0/\pm45/90$ family of graphite/epoxy and boron-graphite/epoxy hybrid laminates, and the $0/\pm45$ family of boron/aluminum laminates were generated.

REPORT NO: AFML-TR-74-105 AD 922 976L
ACCESS NO: 203,049 May 1974
TITLE: COMPOSITE BOX BEAM OPTIMIZATION. VOLLUME II. INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM
AUTHOR(S): P. Donohue
CONTRACT NO: F33615-71-C-1605
CONTRACTOR: Grumman Aerospace Corp.
PROJECT MONITOR: R. Rapson, W. Schulz (AFML/LC)
PROJECT NO: 698CW
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The program was undertaken to extend the technology base for highly loaded composite wing box structure through the selective application of the newer advanced composite material systems and minimization of the use of metallic structural elements. This volume reports the results of a study to further increase the structural efficiency of boron/aluminum to the 550F regime. The use and practicality of secondarily retort brazing boron/aluminum faced Ti honeycomb core sandwich construction in overcoming the limitations of its adhesive bonded counterpart was investigated, as were various aspects of the basic brazing process including core pretreatment and braze alloy requirements. The basic properties; the strength of codiffusion braze bonded overlap and integral stepped joints; and the strength of single shear, double row bolted joints of optimally brazed sandwich panels and plain specimens subjected to the selected braze temperature are reported.

METALS AND CERAMICS DIVISION (AFML/LL)

REPORT NO: AFML-TR-73-77 AD 783 288
ACCESS NO: 202,853 May 1974
TITLE: RELATIONSHIP OF COMPOSITION AND STRUCTURE TO STRENGTH IN TITANIUM ALLOYS
AUTHOR(S): J.F. Breedis
CONTRACT NO: F33615-69-C-1063
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: T.M.F. Ronald (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The strengthening of beta-phase alloys by precipitation, alloying with an interstitial solute and grain refinement have been examined. Also considered in this work are the factors which influence the transition from slip to mechanical twinning as the dominant deformation mode. With regard to precipitation strengthening, omega-phase formation was examined in titanium-vanadium and the possibility of spinodal decomposition was studied in ternary titanium-niobium-metal alloys. The transition between slip and twinning was studied over a range of titanium-vanadium compositions containing between 20 and 95 atomic percent vanadium. No clear changes in activation volume and enthalpy for slip were recognized near the transition from slip to twinning to indicate that no significant changes in slip mechanism occur. Finally, with regard to the influence of interstitial solute and grain refinement on mechanical properties, the influence of oxygen, at three levels of oxygen equivalent, was studied in Ti-18 atomic percent molybdenum-oxygen alloys.

REPORT NO: AFML-TR-73-91 AD 783 291
ACCESS NO: 201,827 April 1974
TITLE: EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM)
AUTHOR(S): V.A. Chase
CONTRACT NO: F33615-71-C-1795
CONTRACTOR: Whittaker Corporation
PROJECT MONITOR: S. R. Lyons (AFML/LLC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program is the development of high temperature circuit analog radar absorbing materials, designs, and prototypes. Material development efforts have involved silica fiber reinforced ceramic composites based on a chemically reacted aluminum phosphate ceramic matrix. Matrix development has involved approaches to achieve thermal expansion compatible with the fibrous reinforcement, while maintaining satisfactory mechanical and electrical properties over an ambient to 1600F range. Simplified fabrication processing characteristics for the composites have been emphasized. Thermal expansion measurements of numerous candidate matrices have been performed. X-ray diffraction studies have been performed to determine crystallographic changes in the candidate matrix materials due to thermal treatment

and/or modification. Composite fabrication and processing characterization studies were performed for five ceramic matrix materials. Flexural properties were determined versus temperature both before and after thermal aging.

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): H. Margolin, E. LeVine, M. Young, I. Greenhut
CONTRACT NO: F33615-72-C-1529
CONTRACTOR: Polytechnic Institute of New York
PROJECT MONITOR: L. R. 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 size increased KQ 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 alpha-beta Ti 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-0.5Cu alloy.

REPORT NO: AFML-TR-73-173
ACCESS NO: 202,428 November 1973
TITLE: THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES: PART I
AUTHOR(S): B.R. Collins, R.L. Thomas
CONTRACT NO: F33615-71-C-1613
CONTRACTOR: Washington University
PROJECT MONITOR: B.R. Collins (AFML/LLC)
PROJECT NO: 7353
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The behavior of a fiber reinforced composite subjected to a general biaxial stress state is discussed in terms of the experimental sensitivity required to precisely define the parameters of an assumed functional form of the limit surface. A micromechanical approach is emphasized with the parametrical evaluation of a graphite/epoxy system used as an example. The experimental portion of the program characterized plate and tubular specimens of boron reinforced aluminum. While the precise limit surface of boron/aluminum was not possible due to the nonuniformity of the boron/aluminum tube specimens, evidence indicates substantial deviation from present limit analyses are

probable. The stress analysis for the potentially nonuniform stress states of the tubes are presented and it is concluded that the thin walled cylindrical tube is an ideal specimen for the intended characterization of this program. Off-axis tensile tests and other simple combined loading tests are shown to lack the appropriate sensitivity for the parametric evaluation of the limit surface functional form. The effects of repressing boron/aluminum plates and the sequential processing of tubes from various broadgood forms is shown to be either beneficial or deleterious, depending on the total amount of processing at various fabrication parameters.

REPORT NO: AFML-TR-73-173
ACCESS NO: 202,427 June 1973
TITLE: THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES. PART II.
AUTHOR(S): A.A. Vicario, W.T. Freeman, P.F. Stecher
CONTRACT NO: F33615-71-C-1613
CONTRACTOR: Washington University
PROJECT MONITOR: B. Collins (AFML/LLC)
PROJECT NO: 7353
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Because of the unique response characteristics of anisotropic composite tubes, new and more sophisticated test procedures and data interpretation techniques are required to determine their stiffness and strength properties. In this respect, considerable attention is being accorded thin-walled cylindrical tubes. The intuitive premise is that because of tube symmetry and fiber continuity over the tube length, a more nearly uniform induced component of stress should be obtainable. The configuration is also economically attractive since it allows for complete properties characterization from a single type of specimen, thus possibly reducing fabrication cost and test equipment investment.

REPORT NO: AFML-TR-73-193
ACCESS NO: 202,429 September 1973
TITLE: NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURE INSPECTION
AUTHOR(S): R.K. Erf, J.P. Waters, R.M. Gagosz, K.A. Stetson, G.Whitney
CONTRACT NO: F33615-71-C-1874
CONTRACTOR: United Aircraft Research Laboratories
PROJECT MONITOR: J.E. Allison (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This program is an investigation of the feasibility of using holographic interferometry for the inspection of large aircraft structures in a manufacturing or maintenance environment. An investigation of the effects of airborne particulates on the holographic process, a study of holographic methods suitable for the manufacturing or maintenance environment, and an investigation and experimental demonstration of two new moire methods for the visualization of strain patterns were conducted. Investigations were also made of potential stress generating mechanisms, in which it was experimentally

demonstrated that surface waves can be generated and attenuated by cracks; holographic observation of such waves may offer the best solution of the crack-detection problem. Experimental demonstrations illustrated the potential of holography, in combination with ultrasonic excitation, for solving cooling passage alignment inspection problems.

REPORT NO: AFML-TR-73-194
ACCESS NO: 202,509 October 1973
TITLE: COMPUTER-AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS
AUTHOR(S): B.G.W. Yee, E.E. Kerlin, A.H. Gardner
CONTRACT NO: F33615-72-C-1828
CONTRACTOR: General Dynamics
PROJECT MONITOR: J. Allison (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes the work performed in the first 12 months of this 30-month contract. The work includes the preliminary design of the overall system operation shown by block diagrams of the subsystem functions and operations and timing diagrams for the three modes of ultrasonic inspection: reflection, transmission, and delta-scan. Progress to date includes the completion of the design of the X-Y scanner, the purchase of a 4 x 6 x 3-ft. tank, and the purchase of the mechanical components, electromechanical controls, and displays necessary for the fabrication of an X-Y scanner capable of operating in the manual or computer controlled mode. The design for the gimbal control is essentially complete with some of the components already in fabrication. A Convair-owned Automation Model UM 771 reflectroscope has been modified to accept programmable gain control from the computer. The electronic circuitries for the gating and computer interfacing have been designed and several have been fabricated.

REPORT NO: AFML-TR-73-200
ACCESS NO: 202,975 September 1974
TITLE: ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APPLICATIONS, VOL. II, TASK II, ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS
AUTHOR(S): R.A. Ekvall, G.S. Hoppin
CONTRACT NO: F33615-72-C-1766
CONTRACTOR: General Electric
PROJECT MONITOR: N. Geyer, W. O'Hara (AFML/LLM)
TASK NO: 731201 (Work Unit 73120136)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Performance analysis of four types of engine systems, turbofans, turbojets, augmented turbojets, and ram and duct-burning engines, for potential gains attainable if combustor liners of coated columbium alloy were used rather than current superalloy liner materials demonstrated that gains in thrust, specific fuel consumption, and turbine efficiency are attainable as the combustor liner cooling air quantities are reduced. However, the gains from using coated columbium liners are offset by increased cooling air requirements for the turbine and exhaust system structural elements necessitated by the higher turbine inlet temperatures. To achieve the full

potential advantage of coated columbium combustor liners, advanced materials must be used for the turbine stator bands and shrouds as well. Coated columbium specimens representative of combustor liner materials were evaluated using flame tunnel cyclic oxidation tests, galling wear tests, and fretting wear test.

REPORT NO: AFML-TR-73-208 AD A002 631
ACCESS NO: 203,206 August 1973
TITLE: GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT
AUTHOR(S): R.R. Sharp, M.C. Flemings
CONTRACT NO: F33615-71-C-1374
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: D.A. Rice, R. Dunco (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: In Part I of this report, solutions are presented for solute redistribution in cellular solidification at high G/R. The solutions assume negligible constitutional supercooling in the vicinity of the growing cells and negligible effects of curvature and interface kinetics. Sample calculations are given for binary aluminum-copper and ternary aluminum-copper-nickel alloys. In Part II, experimental results are presented which describe aspects of solute redistribution during cellular solidification of Al-Cu binary alloys and Al-Cu-Ni ternary alloys. Data are in the form of measurements of cell tip temperature and composition, volume fraction of interdendritic eutectic and, for the ternary system, temperature at which two-phase cells start to form.

REPORT NO: AFML-TR-73-213 AD A000 943
ACCESS NO: 203,101 September 1974
TITLE: EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION
AUTHOR(S): M.G. Benz, E.R. Buchanan, L.V. Hampton, M.F. Henry, M.R. Jackson, L.A. Johnson, J.R. Rairden, T.F. Sawyer, J.L. Walter.
CONTRACT NO: F33615-72-C-1870
CONTRACTOR: General Electric Company
PROJECT MONITOR: D. Rice (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The major goal of this program was to fully evaluate the potential of monocarbide-reinforced eutectic alloys, particularly cobalt-base, for use in aircraft gas turbine applications. The subjects covered in this report include: (1) critical properties: identification and evaluation (prestrain, thermal cycling, thermal cycling under load, low cycle fatigue, microstructural stability, long-time rupture, off-axis properties, oxidation, and hot corrosion); (2) composition (alloying to improve stress rupture behavior); and (3) processing (solidification). We have also included as appendices to this report, work sponsored by the General Electric Co. in areas of interest to the current effort. The subjects covered in these appendices include: background studies in monocarbide-reinforced eutectic alloys, impact, thermal shock, thermal cycling model, and coatings.

REPORT NO: AFML-TR-73-234 AD 778 944
ACCESS NO: 202,664 December 1973
TITLE: RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE
AUTHOR(S): I. Kvernes, P. Kofstad
CONTRACT NO: AFOSR 72-2293
CONTRACTOR: Central Institute for Industrial Research (Norway)
PROJECT MONITOR: O. Srp (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The properties of cyclic furnace oxidation and hot corrosion have been studied on Ni-9Cr-6Al-(0.02-0.1) Y alloys. Samples of both as cast and wrought structures were used. Continuous weight gain measurements and detailed structural analyses have been conducted. A mechanism for pretreatment in dry H2 is proposed and discussed. Metallographic analyses of corroded samples show a catastrophic degradation of the samples by sulfidation and oxidation reactions. A coating of CeO2 or Al2O3 seems to be protective against combustion gases and reduces completely the internal oxidation and sulfidation attacks at 950C.

REPORT NO: AFML-TR-73-259
ACCESS NO: 202,595 October 1973
TITLE: LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES
AUTHOR(S): B. Avitzur, W.C. Hahn, S. Iscovici
CONTRACT NO: F33615-72-C-1153
CONTRACTOR: Lehigh University
PROJECT MONITOR: V. De Pierre (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Both upper and lower bound mathematical solutions are presented for axisymmetric flow through conical converging dies. For the upper bound solution, triangular velocity fields have been solved and compared to previously published work on spherical velocity fields. It is found that each type provides a lower solution over a part of the range of process variables. A previously published lower bound solution for axisymmetric flow is refined.

REPORT NO: AFML-TR-73-281 AD 776 293
ACCESS NO: 202,538 December 1973
TITLE: INVESTIGATION OF PARAMETERS INVOLVED IN METAL PROCESSING OPERATIONS
AUTHOR(S): D.J. Abson, F.J. Gurney
CONTRACT NO: F33615-71-C-1163
CONTRACTOR: Westinghouse Astronuclear Lab
PROJECT MONITOR: V. De Pierre, A.M. Adair (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report summarizes the findings of several investigations involving the influence of process variables on the production of shapes with specified geometry and controlled microstructure. The studies included: the extrusion consolidation of pre-alloyed metal powders (7075 Al and Rene' 95); a refinement of the analysis and application of the ring

compression test; the use of hardness testing to evaluate the strength of hot deformed product; investigations of the effect of processing variables on extruded product and extrusion pressures; the fabrication of a heated die forging system and a preliminary investigation of lubricants; an analysis of some published flow stress data for Ti-6Al-4V; studies of grain growth in some titanium-base alloys and a comparison of grain boundary and sub-boundary strengthening in aluminum.

REPORT NO: AFML-TR-73-296
ACCESS NO: 200,960 January 1974
TITLE: DEVELOPMENT OF ECONOMICAL SHEET TITANIUM ALLOY
AUTHOR(S): T.L. Wardlaw, H.W. Rosenberg, W.M. Parris
CONTRACT NO: F33615-72-C-1696
CONTRACTOR: Titanium Metals Corp. of America
PROJECT MONITOR: R.F. Geisendorfer, J.A. Hall (AFML/LLM)
PROJECT NO: 7351
TASK NO: 735105
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program was to develop an economical sheet titanium alloy. The approach was to build on the earlier work with emphasis on mill product economics consistent with formability, fabricability, and other properties required by the ultimate user. Including alloys from the earlier contracts, more than 60 compositions were evaluated. These were narrowed to three finalist compositions, Ti-8V-7Cr-3Al-4Sn-1Zr, Ti-8V-4Cr-2Mo-2Fe-3Al, and Ti-15V-3Cr-3Al-3Sn. Further work is recommended on all three. Each alloy exhibits good strip producibility potential while meeting the airframe industry's stated cold minimum bend requirements. Each alloy showed Erichsen cup draw depths exceeding 0.35 in. after simulated strip processing to about 0.040 in. gage.

REPORT NO: AFML-TR-73-297 AD 778 462
ACCESS NO: 202,666 December 1973
TITLE: THE DEVELOPMENT OF HEAT-RESISTANT TITANIUM ALLOYS
AUTHOR(S): M. Hoch, N.C. Birla, S.A. Cole
CONTRACT NO: F33615-69-C-1529
CONTRACTOR: University of Cincinnati
PROJECT MONITOR: H.Gegel (AFML/LLP)
PROJECT NO: 7351
TASK NO: 735103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A classification for heat resistant titanium alloys was developed and possible new approaches for synthesizing new high temperature alloys were elucidated. X-ray diffraction techniques were used to determine the strain in the alpha-phase of Ti-Al-Ga alloys associated with the alpha 2 phase caused by the addition of Al and/or Ga. An attempt was made to determine the phase boundary between alpha and (alpha + alpha 2) in the Ti-Al-Ga ternary system. The thermodynamic properties of titanium-aluminum, titanium-gallium, titanium-tin and titanium-aluminum-gallium were investigated.

Thermodynamic activity measurements and binary interaction parameters were obtained using a high temperature Knudsen cell coupled with a time-of-flight mass spectrometer.

REPORT NO: AFML-TR-73-302 AD 779 674
ACCESS NO: 202,568 December 1973
TITLE: THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK
AUTHOR(S): L.B. Freund
CONTRACT NO: F33615-73-C-5089
CONTRACTOR: Brown University
PROJECT MONITOR: T. Nicholas (AFML/LLN)
PROJECT NO: 7353
TASK NO: 735303
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The plane strain problem of a half-plane crack in an unbounded elastic solid is considered. The faces of the crack are subjected to suddenly applied, equal but opposite concentrated normal forces which tend to separate the crack faces. The elastic wave propagation problem, which contains a characteristic length, is solved exactly by linear superposition over a fundamental solution arising from a particular problem in the dynamic theory of elastic dislocations. Attention is focused on the time-dependent stress intensity factor. For an applied load with step function time dependence, the stress intensity factor is negative from the time the first wave arrives at the crack tip until the arrival of the Rayleigh wave. At that instant, it takes on its appropriate static value, which is thereafter maintained. Generalizations are discussed for spatially distributed and/or time-varying normal impact loads.

REPORT NO: AFML-TR-73-305 AD 783 234
ACCESS NO: 203,005 March 1974
TITLE: CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER
AUTHOR(S): D.G. Jones
CONTRACT NO: F33615-73-C-5028
CONTRACTOR: University of Dayton, Sikorsky Aircraft
PROJECT MONITOR: D.G. Jones (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes some of the results of an investigation to evaluate the effect of constrained layer damping treatments on cabin noise levels in an HH-53C helicopter. Vibration and noise levels were measured for various flight conditions, including hover, forward flight and banked, and in each case it was observed that the damping treatment reduced vibration and noise levels, in certain frequency bands within which

natural modes of vibration were strongly excited. Ground vibration tests under artificial excitation and laboratory vibration tests on simpler but related structures were also conducted to further understand the phenomena involved and to develop appropriate damping treatments for broad temperature range noise control applications.

REPORT NO: AFML-TR-74-8 AD 783 324
ACCESS NO: 202,937 May 1974
TITLE: IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS
AUTHOR(S): D.H. Timbres, L.F. Norris
CONTRACT NO: F33615-72-C-1345
CONTRACTOR: Sherritt Gordon Mines, Ltd.
PROJECT MONITOR: W.T. O'Hara (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A dispersion strengthened nickel-base alloy, Ni/16Cr/5Al/2ThO2, exhibiting excellent high temperature oxidation resistance, was subjected to a series of thermomechanical processing studies to optimize its mechanical properties. A reproducible process yielding the desired coarse grain microstructure and fine dispersoid size in wrought strip was defined which included the steps of roll consolidating sintered powder compacts at 2000F, rolling in a series of 10% reductions at 2200F and then annealing at 2400F. The short time tensile properties at room temperature and 2000F in the longitudinal and transverse directions were similar but the transverse stress rupture and room temperature ductility properties were lower than those in the longitudinal direction. All properties with the exception of room temperature ductility were above the target specifications for the program.

REPORT NO: AFML-TR-74-15 AD 777 165
ACCESS NO: 202,558 February 1974
TITLE: FAILURE PROCESSES IN METAL MATRIX COMPOSITES
AUTHOR(S): R.G. Carlson
CONTRACT NO: F33615-72-C-1713
CONTRACTOR: General Electric
PROJECT MONITOR: E. Joseph (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Boron/aluminum (B/Al) composite blades have been consolidated and impacted by RTV "birds." Failure responses have been observed. The blade deflections as determined by high speed movies have been compared with calculated values generated from an AFML model and gave good agreement. Analyses of the strain gage responses yield inherent stress levels, resonant frequencies, and logarithmic decrement of these blades.

REPORT NO: AFML-TR-74-18 AD 919 332L
ACCESS NO: 202,597 March 1974
TITLE: WEAR AND FRETTING FATIGUE RESISTANT COATINGS FOR TITANIUM ALLOYS

AUTHOR(S): R.K. Betts
CONTRACT NO: F33615-72-C-1472
CONTRACTOR: General Electric
PROJECT MONITOR: N. Geyer (AFML/LLM)
PROJECT NO: 7312
TASK NO: 731201
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Studies were performed to identify treatments to alleviate the effects of wear on fatigue properties of Ti-6Al-4V, Ti-5Al-4Mo-4Cr-2Sn-2Zr (Ti-17) and Ti-8Al-1Mo-1V. The mechanisms of wear studied were fretting fatigue and sliding wear fatigue. Surface treatments including Tibon II Cr electroplating, Tiduran case hardening, SermeTel W coating and an Al-Si-bronze alloy shim did not protect against fretting fatigue. In sliding wear tests of all three Ti alloys at room temperature, a plasma-sprayed coating of Al-bronze (Metco 51) containing 10% Ekonol (carborundum polyimide) prevented loss of fatigue strength. Other coatings and surface treatments evaluated did not afford complete wear protection. These included Tiodize II anodizing, Tibon II Cr electroplating, Selectronics brush-electroplated Sn and Zn, Brunsmet DH-242 fiber shim, Clevite 147 Al-Sn-Cd alloy shim, and electroplated Cu.

REPORT NO: AFML-TR-74-21 AD 779 677
ACCESS NO: 202,686 December 1973
TITLE: THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES
AUTHOR(S): K.J. Barker, B. Avitzur, and W.C. Hahn, Jr.
CONTRACT NO: F33615-72-C-1153
CONTRACTOR: Lehigh University
PROJECT MONITOR: V. De Pierre (AFML/LLM)
PROJECT NO: 7351
TASK NO: 735108
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effects of friction upon the intermediate and final distorted grids for wire drawing and/or extrusion were analytically studied for an assumed triangular velocity field. An upper-bound solution for the process was used. This solution predicted that the shape of the final and intermediate distorted grids were functions of the process geometry and of friction. Initially, combinations of reduction and semi-cone angle were found for which the triangular velocity field was energetically preferred over an existing spherical velocity field. The analytical final distorted grids were then compared to experimentally obtained final distorted grids to determine the experimental friction. This was done by plotting calibration curves for distortion where friction served as the parameter and by comparing the actual distortion with the family of calibration curves.

AFML/LL

REPORT NO: AFML-TR-74-31 AD 783 235
ACCESS NO: 202,856 June 1974
TITLE: DEHYDRIDING OF TITANIUM ALLOY (Ti-6246) HYDRIDED POWDER
AUTHOR(S): N. Birla, V. De Pierre
CONTRACT NO: N/A
CONTRACTOR: University of Cincinnati
PROJECT MONITOR: V. De Pierre (AFML/LLS)
PROJECT NO: 7351
TASK NO: 735108
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A systematic investigation of temperature-pressure-time variables for dehydriding titanium alloy (Ti-6246) powder was made to determine practical processing conditions for reducing the hydrogen content of the powder to levels below 100 ppm. Analyses of the experimental results of tests made between 1200F and 1500F indicate that 1500F is the optimum dehydriding temperature. The controlling process for dehydriding can be expressed by second order reaction 2H(gas) = H2(gas) with an activation energy of 21,760±1840 cal. Below 0.088 micron partial pressure of hydrogen, the type of vacuum system used for dehydriding is believed to be the major factor for removal of these molecules.

REPORT NO: AFML-TR-74-34 AD 779 934
ACCESS NO: 202,681 March 1974
TITLE: FEASIBILITY OF MAKING AN OXIDE DISPERSION-STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION
AUTHOR(S): D.L. Klarstrom, R. Grierson
CONTRACT NO: F33615-73-C-5150
CONTRACTOR: Cabot Corporation
PROJECT MONITOR: W.T. O'Harra (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The feasibility of making an oxide dispersion-strengthened cobalt-base alloy by mechanical attrition was investigated. The optimum blend of starting powders to produce a Co-20Ni-18Cr-1Y2O3 base composition was determined. Using this blend, four different alloys were produced: two contained 1% and 2% Y2O3 and no aluminum, and two contained 1% and 4% aluminum with 1% Y2O3, respectively. A full scale property evaluation was performed for each alloy composition on extrusions produced at four different temperatures with a reduction ratio of 16:1.

REPORT NO: AFML-TR-74-40 AD 783 293
ACCESS NO: 202,842 March 1974
TITLE: EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES
AUTHOR(S): K.M. Prewo
CONTRACT NO: F33615-73-C-5152
CONTRACTOR: United Aircraft Corporation

PROJECT MONITOR: E. Joseph (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Boron fiber reinforced aluminum matrix composites can be successfully fabricated in air with total hot pressing times of ten minutes or less. These composites have been fabricated without the need for elaborate bagging or outgassing procedures and demonstrate that significant cost savings in processing can be achieved without any sacrifice in composite performance. The process procedure, referred to as "quick bonding," is fully described in this report along with resultant composite tensile and fatigue properties. Composite panels were fabricated in constant and nonconstant cross section configurations with composite panel dimensions exceeding those of the hot press using single and multiple step pressing procedures. Specimens exhibited axial tensile strengths of up to 290,000 psi, transverse tensile strengths of 30,000 psi, and transverse tensile failure strains of over 1 percent.

REPORT NO: AFML-TR-74-44 AD 784 920
ACCESS NO: 202,926 March 1974
TITLE: STRESS ANALYSIS OF COLDWORKED FASTENER HOLES
AUTHOR(S): W.F. Adler, D.M. Dupree
CONTRACT NO: F33615-73-C-5170
CONTRACTOR: Bell Aerospace Company
PROJECT MONITOR: A.F. Grandt (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The stress and strain distributions around an initially cold-worked hole in a plate and the subsequent redistribution of the stresses and strains when the plate is subjected to a uniform tensile loading are evaluated both analytically and experimentally. An elastic-plastic finite element idealization is developed for a one-quarter inch diameter hole in a 7075-T6 aluminum alloy plate one-quarter inch thick. Stress and strain distributions are provided for a 6 mil radial expansion of the hole and at tensile load levels of 10,000 lb., 25,000 lb., 37,500 lb., and 42,500 lb. Moire interferometry was used to verify that the elastic-plastic finite element analysis is representative of the strain distributions in an actual fastener coldworking procedure which involves inserting a cylindrical sleeve into a nominal one-quarter inch diameter hole and then drawing an oversized mandrel through the hole to produce a symmetrical distribution of residual stresses around the hole.

REPORT NO: AFML-TR-74-48 AD 779 720
ACCESS NO: 202,701 April 1974
TITLE: PROJECT THEMIS: METAL DEFORMATION PROCESSING
AUTHOR(S): H. Conrad, M. Doner
CONTRACT NO: F33615-69-C-1027
CONTRACTOR: University of Kentucky
PROJECT MONITOR: A. Adair (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.

ABSTRACT: A new analytical approach was developed for establishing the local stress state and temperature (including regions near the surface) in axisymmetric extrusions. Also a numerical method (finite differences) for solving the plasticity equations and thereby predicting the flow lines has been developed.

REPORT NO: AFML-TR-74-71 AD 786 027
ACCESS NO: 202,971 July 1974
TITLE: STRESS INTENSITY FACTORS FOR SOME THRU-CRACKED FASTENER HOLES
AUTHOR(S): A.F. Grandt
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: A. Grandt (AFML/LLP)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A stress intensity factor solution is developed for a large plate containing radial hole cracks loaded with arbitrary crack face pressure. When the pressure is defined as the unflawed hoop stress surrounding a mechanical fastener, stress intensity factor calibrations are readily computed by the linear superposition principle. Results obtained in this manner agree well with previous solutions determined for open holes loaded in remote tension. The potential usefulness of the present analysis is further demonstrated with application to specific fastener configurations, including interference fit fasteners, pin-loaded plates, and cold-worked holes.

REPORT NO: AFML-TR-74-74
ACCESS NO: 202,631 February 1974
TITLE: MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES
AUTHOR(S): F.K. Tsou, Pei Chi Chou, I. Singh
CONTRACT NO: F33615-72-C-1778
CONTRACTOR: Drexel University
PROJECT MONITOR: A. Hopkins (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A multi-control-volume method is developed to predict the wave velocities and stresses in the elastic and plastic regions of layered composites. From the method, the wave velocities and stresses may be calculated from the constitutive relations of its constituents. The interfacial shearing force may then be computed. Two composites (boron/aluminum and graphite/C-7 epoxy) have been used for sample calculations. The calculated wave velocities will differ from a constant as the velocity becomes large.

AFML/LL

REPORT NO: AFML-TR-74-75 AD A001 621
ACCESS NO: 203,041 July 1974
TITLE: A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT
AUTHOR(S): W. Sharpe, A. Grandt
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: W. Sharpe, A. Grandt (AFML/LLN)
PROJECT NO: 7351
TASK NO: 735106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The opening of a fatigue crack in an aluminum specimen was measured by optical interference from single grooves ruled on both sides of the crack. Displacement can be measured with a sensitivity of 0.1 micron, making the technique particularly useful in studies of crack closure. Details of this easy, inexpensive technique are discussed in this report. The procedure is to polish the sample surface and cut grooves on each side of the crack. The grooves are illuminated with a laser, the light is diffracted from the sides of the grooves, and the overlapping of the two diffracted patterns produces two sets of interference fringes. As the crack opens, the fringes emanating from the grooves near the crack move, whereas those emanating from in front of the crack do not. By measuring the fringe motion relative to the immobile fringes, one can determine the crack opening displacement at any position along the crack.

REPORT NO: AFML-TR-74-80
ACCESS NO: 203,212 April 1974
TITLE: DETECTION OF CRACKS UNDER INSTALLED FASTENERS
AUTHOR(S): C.F. Raatz, R.A. Senske, W.E. Woodmansee
CONTRACT NO: F33615-72-C-1205
CONTRACTOR: Boeing Commercial Airplane Company
PROJECT MONITOR: D. Corbly (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The overall objective of this 2-year program was the development of a reliable nondestructive method of detecting cracks under installed fasteners, emphasizing improvement of the ultrasonic shear wave method. The program included the implementation of the developed method into a system suitable for on-line inspection of airplanes. The development effort proceeded in four main areas: ultrasonic fastener-hole scanning techniques, display of test information, identification of transducer requirements, and portable-scanner design.

REPORT NO: AFML-TR-74-100
ACCESS NO: 203,268 October 1974
TITLE: THE INFLUENCE OF MICROSTRUCTURE ON THE TENSILE BEHAVIOR OF RENE´ 95
AUTHOR(S): M.N. Menon, W.H. Reimann

CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: W. Reimann (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A transmission and scanning electron microscope study has been conducted on the deformation and fracture behavior of Rene' 95, an advanced superalloy developed for use as a disk material in gas turbine engines. In addition to the normal solid solution strengthening and precipitation strengthening mechanisms, Rene'95 derives part of its strength from thermomechanical processing. In this paper, the tensile mechanical properties, deformation structure, and tensile fracture characteristics of Rene' 95 are examined and related to the microstructure. The results are compared with those from the conventionally processed material (without TMP), and an attempt is made to account for the factors that influence the tensile characteristics of these two materials.

REPORT NO: AFML-TR-74-108
ACCESS NO: 203,300 November 1974
TITLE: AN EVALUATION OF THE EFFECTS OF CYCLIC LOADING ON THE STRENGTH OF ZINC SELENIDE
AUTHOR(S): G.R. Atkins
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: G. Atkins (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An investigation of the possible effects of cyclic loading on the strength of zinc selenide was conducted. Experimental results indicate no apparent reduction in strength due to cyclic loading.

REPORT NO: AFML-TR-74-124 AD A002 310
ACCESS NO: 203,187 July 1974
TITLE: DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING
AUTHOR(S): J.P. Butler, D.A. Rees
CONTRACT NO: F33615-72-C-2003
CONTRACTOR: Boeing Commercial Airplane Company
PROJECT MONITOR: R. Donat (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Thirty-two unique multi-detail specimens were tested to develop a data base for investigation of the statistical materials/structures fatigue failure characteristics of 2024-T3 aluminum alloy in the form of 0.225-in. thick sheet. Twelve of these specimens were 36 by 120 inches in size and contained a central, 10-row, 11-column matrix of 110 open holes at a regular spacing providing a similar and independent local stress-field exposure at each detail. The remaining 20 specimens were 10 by 65 inches in size and contained a central, 10-row, 2-column matrix of 20 details which were

open holes, filled holes, or one of two levels of load transfer at fasteners, with the load transfer accomplished by double shear through local doubler straps with a fastener in each end of the straps. A limited sampling of three heats of materials was included in the program.

REPORT NO: AFML-TR-74-129, Part I
ACCESS NO: 203,237 December 1974
TITLE: RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS. PART I. THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES
AUTHOR(S): A.R. Rosenfield, C.W. Price, C.J. Martin
CONTRACT NO: F33615-71-C-1805
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: D.P. Voss, W.M. Griffith (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effects of the various small, intermediate, and large precipitates on the fracture toughness and fatigue properties of aluminum alloys based on the 2024 and 7075 compositions were studied. Different concentrations and sizes of the precipitates were obtained by systematic variations in the chemical composition and also in the homogenization and aging treatments. Aging treatments were selected to produce approximately equal yield strengths in the underaged and overaged conditions. The roles of the various precipitates in deformation and fracture were determined by slip-line and fractographic studies, and these results were carefully correlated with the fracture toughness data.

REPORT NO: AFML-TR-74-129, Part II
ACCESS NO: 202,847 August 1974
TITLE: RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS. PART II. CONTROL OF GRAIN STRUCTURE DURING HOT WORKING
AUTHOR(S): D.C. Drennen, C.W. Price, D.N. Williams
CONTRACT NO: F33615-71-C-1805
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: W.Griffith (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effects of deformation parameters on the tendency of 2024 aluminum alloy to recrystallize either during hot working or during subsequent solution heat treatment were examined. Samples were upset under controlled conditions in the Gleeble programmed thermal-mechanical test machine. The behaviour of homogenized 2024 was compared with that of high purity Al-4.6Cu alloy and with cast 2024 and 2124. Based on the Gleeble results, hot rolling procedures were designed for producing a fine equiaxed grain structure in sheet rolled from either homogenized 2024 or cast 2124. A limited quantity of sheet was rolled according to these procedures and evaluated to determine tensile and fatigue properties.

AFML/LL

REPORT NO: AFML-TR-74-130
ACCESS NO: 203,298 October 1974
TITLE: NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURES INSPECTION
AUTHOR(S): R.K. Erf, R.M. Gagosz, J.P. Waters, K.A. Stetson, H.G. Aas
CONTRACT NO: F33615-71-C-1874
CONTRACTOR: United Aircraft Research Laboratories
PROJECT MONITOR: J. Allison (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The theoretical and experimental work, performed during a three year study concerned with a research investigation of nondestructive holographic techniques for structures inspection, are reviewed herein, and provided the following results relevant to the major areas of endeavor; the deleterious effects of ambient light, vibration and particulate matter may be overcome with the use of pulsed laser systems; surface finishes varying in roughness from 4 microinches to 1000 microinches are compatible with the holographic process; examination of specific components at the operating divisions of United Aircraft demonstrated the capability for finding defects in propellor and rotor blades subjected to fatigue cycling and for recording interferograms of over 100 square feet of a helicopter airframe, etc.

REPORT NO: AFML-TR-74-142 AD A002 630
ACCESS NO: 203,219 July 1974
TITLE: METAL PROCESSING OPERATIONS. VOLUME I: GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE
AUTHOR(S): D.J. Abson
CONTRACT NO: F33615-74-C-5059
CONTRACTOR: Westinghouse Astronuclear Laboratory
PROJECT MONITOR: A. Adair (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Data on the room temperature strength of polycrystalline aluminum appearing in the literature have been analysed to separate and to compare the strength contributions from grain boundaries and from sub-boundaries; it had been shown that, for the same boundary density, cold work and anneal sub-boundaries make a greater contribution to strength than grain boundaries. The analysis has also shown that hot work sub-boundaries make a smaller contribution than grain boundaries for subgrain and grain sizes larger than approximately $3 \times 10^{-6}$ m; below this size, however, hot work sub-boundaries make the greater contribution to strength, and this becomes comparable with the strength contribution expected from cold work and anneal sub-boundaries at about $1 \times 10^{-6}$ m.

REPORT NO: AFML-TR-74-159 AD A001 611
ACCESS NO: 203,149 August 1974
TITLE: FRACTURE CRITERION FOR MATERIALS IN PLASTIC DEFORMATION PROCESSES

AUTHOR(S): S. Kobayashi, S. T. Oh
CONTRACT NO: F33615-72-C-1645
CONTRACTOR: University of California
PROJECT MONITOR: V. De Pierre (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The investigation is aimed at establishing the workability of aluminum alloy 7075-T6 in upsetting and rolling at room temperature with reference to occurrence of free-surface cracks. The fracture criterion was established by a plane-strain sheet tension test and an upset test. For obtaining the complete solution in upsetting an improved version of the matrix method was used. Then, a workability chart was constructed by combining the fracture criterion and the complete solution for various friction conditions and several special dimensions. In rolling, a mathematically sound theory was developed for the analysis of spread. With this theory it was possible to predict workability in rolling with reference to edge cracking. The limiting reductions in thickness were given as functions of workpiece dimensions for various friction values. Experimental results demonstrated that the predictions were very good.

REPORT NO: AFML-TR-74-160
ACCESS NO: 203,182 August 1974
TITLE: FORMULATION OF THE LIMITING DUCTILITY IN METALWORKING PROCESSES
AUTHOR(S): J.W. Spretnak
CONTRACT NO: F33615-72-C-1645
CONTRACTOR: Ohio State University
PROJECT MONITOR: V. De Pierre (AFML/LLM)
DIST. STATEMENT: Approved for public release; distribution unlimited
ABSTRACT: The concepts of workability in metalworking processes are examined. The most common limitation is pore formation and coalescence to form internal cracks in the absence of a free surface and cracks at free surfaces. Pore coalescence in technical alloys occurs largely by microinstabilities rather than by reducing the ligament to zero cross-sectional area by plastic flow. The mechanism of ductile fracture is examined, including homogeneous and heterogeneous nucleation, and nucleation by the hydrodynamic separation phenomenon. The effect of a hydrostatic pressure is examined along with factors controlling ductility at elevated temperatures. The two most important variables affecting ductile fracture are the volume fraction of the second-phase particles and the hydrostatic pressure component.

REPORT NO: AFML-TR-74-172
ACCESS NO: 203,185 July 1974
TITLE: BIAXIAL STRENGTH TESTS ON BERYLLIUM AND TITANIUM ALLOYS
AUTHOR(S): U.S. Lindholm, L.M. Yeakley, D.L. Davidson
CONTRACT NO: F33615-71-C-1608
CONTRACTOR: Southwest Research Institute
PROJECT MONITOR: M. Sever (AFML/LLN)

DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Results of extensive biaxial testing of two new grades of beryllium and two titanium alloys, 6Al-4V and 6Al-6V-2Sn, are presented. The tests are conducted on thin-walled tubular specimens subject to combinations of axial load, torsion, and internal pressure. The results include description of the yield, plastic flow,and failure properties of these alloys under plane stress conditions. In each case, yield and plastic flow is adequately described by a Mises yield criterion and associated flow rule. Tensile failure is more accurately described by a maximum stress criterion, particularly for the beryllium which has low ductility. Biaxial ductility is shown to be very sensitive to both the form of the failure stress criterion and to the strain hardening modulus of the material. The effect of prestraining on subsequent ductility in beryllium is examined.

REPORT NO: AFML-TR-74-173 AD A004 460
ACCESS NO: 203,253 December 1974
TITLE: HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE
AUTHOR(S): J. Klepaczko, R.A. Frantz, J. Duffy
CONTRACT NO: F33615-73-C-5089
CONTRACTOR: Brown University
PROJECT MONITOR: T. Nicholas (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A review is presented of available experimental data on strain rate and temperature history effects for fcc polycrystalline metals together with new experimental results on copper and lead. It is evident from all the data presented that history effects play an important role which cannot be neglected in deriving constitutive relations to describe the plastic behavior of metals. It is shown in this paper that the influence of strain rate or temperature on the flow stress can be divided into two parts. The initial part is due to the existing work-hardened structure at that strain level, while the second is associated with the formation history of that structure. A possible explanation for these effects lies in dynamic recovery processes which take place during the slower deformation before the imposition of the rapid change in strain rate or temperature.

REPORT NO: AFML-TR-74-187
ACCESS NO: 203,186 December 1974
TITLE: DEVELOPMENT OF A VERY HIGH STRENGTH DISK ALLOY FOR 1400F SERVICE
AUTHOR(S): J.L. Bartos
CONTRACT NO: F33615-72-C-1797
CONTRACTOR: General Electric
PROJECT MONITOR: W. Reimann (AFML/LLN)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The primary objective of this program was to develop an advanced powder metallurgy disk alloy for 1400 F service which combined high tensile and creep rupture properties with exceptional low cycle fatigue

strength. A three-phase experimental program was designed to accomplish this goal. Preliminary studies were conducted prior to initiation of Phase I to identify seven alloy/process combinations to be evaluated in Phase I. Mechanical property screening tests were conducted on subscale disks during Phase I in order to define one alloy/process combination for scale-up in Phase II. Phase III of the program consisted of a cursory alloy development effort directed at exploring the potential of relatively low density superalloys.

REPORT NO: AFML-TR-74-194 AD A002 670
ACCESS NO: 203,220 October 1974
TITLE: ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES
AUTHOR(S): G.S. Doble, P. Melnyk, I.J. Toth
CONTRACT NO: F33615-74-C-5076
CONTRACTOR: TRW Inc.
PROJECT MONITOR: E. Joseph (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A low-cost process for the primary roll diffusion bonding of boron-aluminum monotapes and multi-ply panels in air has been developed. Heating was performed in either air or argon with properties equivalent to higher cost vacuum and press bonded material. The average tensile strengths of roll bonded monotapes was 207 ksi with secondary press bonded panel strengths being 201 ksi longitudinal and 19 ksi transverse. Panels containing interleaved titanium foil of 18-26 volume percent were produced by primary and secondary roll binding with 200 ksi longitudinal and 46-70 ksi transverse strengths. Cost projections indicate processing costs of $40, $19, and $13/lb for boron-aluminum monotape at an annual production volume of 2,000, 20,000 and 200,000 pounds.

REPORT NO: AFML-TR-74-231
ACCESS NO: 203,335 November 1974
TITLE: STATIC AND DYNAMIC INTERPRETATION OF TITANIUM ALLOY PHOTOMICROGRAPH FEATURES
AUTHOR(S): J.J. Dreher
CONTRACT NO: F33615-73-C-5108
CONTRACTOR: Dr. John Dreher
PROJECT MONITOR: T. Ronald (AFML/LLS)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Computer and hand generated geometrical data from Ti-6Al-2Sn-4Zr-6Mo photomicrographs were statistically treated to establish family groupings of certain physical properties. These families, established by duration and freepath distribution functions, define various statistically different packets of mechanical properties which correlate to various degrees with other measured geometries. Following an Air Force Materials Laboratory specification of an acceptable mechanical property profile, ten qualifying samples were additionally subjected to analyses sensitive to particle mass and spatial placement. Two novel methods, autocorrelation of particle mass

equivalents and a stroboscopic pattern detection technique, indicated the interrelations of spatial distribution patterns and the properties of ductility, fatigue resistance, toughness, and crack propagation.

AD A003 672

REPORT NO: AFML-TR-74-238
ACCESS NO: 203,265
TITLE: PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION
AUTHOR(S): D.O. Thompson
CONTRACT NO: F33615-74-C-5180
CONTRACTOR: Rockwell International
PROJECT MONITOR: M. Buckley (AFML/LLP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: In this report the transcripts of the Workshop for Quantitative Flaw Definition held at the Science Center, Rockwell International, June 17-20, 1974, are presented. Besides an introductory session which emphasizes NDE needs and costs in various branches of the DOD, three sessions are devoted to three key problem areas which are examined in some detail. These problem areas include the quantitative evaluation of flaws, the non-destructive evaluation of composites and adhesively bonded materials, and the detection of residual stresses and other failure related properties. These sessions are composed of both tutorial presentations defining both the problems and the incomplete solutions presently available, and reports of research in progress in the related areas. Group discussions associated with these presentations are also given.

November 1974

ELECTROMAGNETIC MATERIALS DIVISION (AFML/LP)

REPORT NO: AFML-TR-73-106
ACCESS NO: 202,594 June 1973
TITLE: STUDIES ON PASSIVE Q-SWITCH MATERIALS FOR LASERS
AUTHOR(S): J. Margerum, S. Wong, R. Brault, C. Giuliano, H. Kimura, A. Lackner, M. Little, R. Pastor, G. Rickel, B. Soffer.
CONTRACT NO: F33615-71-C-1171
CONTRACTOR: Hughes Research Laboratories
PROJECT MONITOR: H. Rosenberg (AFML/LP)
PROJECT NO: 7367
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Passive Q-switch (PQS) dyes and their fatigue mechanisms were investigated to improve PQS materials for ruby lasers. Studies were made on dye structure and solvent effects on the spectra, photostability, optical saturation,and PQS performance. Synthesized dyes included: four salts of cryptocyanine (A-I); 1,1 -diisobutyl-4,4' -carbocyanine (B-I); 3,3' -diethyl -6,6' -dinitrothiadicarbocyanine iodide (D-I); and 3,3' - dihexyl-6,6' -dinitrothiadicarbocyanine iodide (D-IV). Laser optical saturation occurred at lower powers for D-I and D-IV as compared to A-I. PQS performance studies showed lower pumping thresholds and higher power laser outputs for D-I and D-IV in HFIP or methanols as compared to cryptocyanine (A-I).

REPORT: AFML-TR-73-153
ACCESS NO: 202,503 August 1973
TITLE: EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS
AUTHOR(S): D.M. Heinz, R.D. Henry
CONTRACT NO: F33615-73-C-5017
CONTRACTOR: Rockwell International
PROJECT MONITOR: H. Garrett (AFML/LP)
PROJECT NO: 7371
TASK NO: 737103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Test performed on bubble domain materials indicates that they are resistant to mechanical stresses of 50G. In a study of FMR and bubble domain wall mobility, it was found that the mobility is quite temperature sensitive over the range of interest, that FMR gives an upper bound but not a true value of mobility and that the exchange constant is about 0.6 of the normally assumed value for bubble domain compositions. An investigation aimed at selecting a composition to meet Air Force computer memory goals indicates that lower wall energy materials will have to be employed to reach high data rates.

REPORT NO: AFML-TR-73-163
ACCESS NO: 202,615 September 1973
TITLE: THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMI-CONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS
AUTHOR(S): L.R. Shiozawa, J.M. Jose, D.A. Roberts

CONTRACT NO: F33615-71-C-1777
CONTRACTOR: Gould Laboratories
PROJECT MONITOR: G. Kuhl (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Physical vapor deposited (PVD) polycrystalline windows of CdTe prepared at temperatures above 950C yield typical calorimetric absorption coefficients of about 0.002 $cm^{-1}$ after suitable treatment in Cd and Te vapors. ZnSe windows prepared at about 1150C in graphite crucibles have calorimetric absorption coefficients without heat treatment of about 0.016 $cm^{-1}$ and scattering coefficients of about 0.04 $cm^{-1}$, due largely to grown-in voids. Homogeneity measurements indicate that the intrinsic absorption coefficients of CdTe and ZnSe are less than 0.0006 and less than 0.004 $cm^{-1}$, respectively. Absorption measurements following various heat treatments are summarized for all sixty-three windows that were treated under the present program. Achievement of low absorption does not correlate with growth temperature, doping concentration, duration of run, or cooling rate.

REPORT NO: AFML-TR-73-214 AD 917 699
ACCESS NO: 201,824 September 1973
TITLE: LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGHPOWER IR LASERS
AUTHOR(S): G. Johnston, J. Detrio, J. Schneider
CONTRACT NO: F33615-71-C-1816
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: D. Stevison (AFML/LPJ)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report describes the efforts to establish and operate an experimental facility at the Air Force Materials Laboratory for the optical evaluation of materials of potential use as high power IR laser windows. Primary emphasis was directed at experimental determinations of the **absorption** coefficient at 10.6 um of window material samples from the data of the $CO_2$ laser ballistic calorimeter. More than 600 samples were received for characterization tests. Secondary efforts have been directed toward measurements of optical **absorption** homogeneity, thermal lensing, dn/dt, and scattering. A program of depositing and analyzing coatings was begun in January 1973.

REPORT NO: AFML-TR-73-250
ACCESS NO: 202,436 October 1973
TITLE: AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF Nd1-x SmxCo5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION
AUTHOR(S): I. Maartense
CONTRACT NO: F33615-73-C-5060
CONTRACTOR: University of Manitoba
PROJECT MONITOR: R. Hutchens, D. Evans (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Measurements are reported on the ac susceptibility of Nd1-xSmCo5 single crystals, with x = 0, 0.25, 0.5, 0.75, and 1.0. The spin

reorientation temperature which occurs at 281K in NdCo5, is found to occur at 167K and 140K in the alloys with x = 0.25 and 0.5. Small quantities of absorbed hydrogen raise these temperatures by a few degrees. When a swept biasing field is reversed, the presence of an internal critical field is noted as well as rate dependent losses which cause an apparent drop in the susceptibility. The presence of hydrogen causes a doubling of this field as well as an increase in the losses, which are associated with strong Barkhausen discontinuities. In NdCo5 a strong hydrogen-induced relaxation characterized by an activation energy of 0.4 eV is seen below 220K. Additional relaxations occur near 375K and 720K.

REPORT NO: AFML-TR-73-274
ACCESS NO: 202,430 November 1973
TITLE: MAGNETIC NEUTRON DIFFRACTION STUDIES OF PrCo5 and SmCo5
AUTHOR(S): K. Morash, B. Averbach
CONTRACT NO: F33615-72-C-1323
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: H. Garrett (AFML/LP)
PROJECT NO: 7367
TASK NO: 736703
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: We have examined PrCo5 powder samples by x-ray and neutron diffraction in order to determine the magnetic moments on the Pr and Co atoms. These data were analyzed assuming different spin orientation models. The only model which gave reasonable results was one of ferromagnetic coupling of the Pr and Co moments with the moment lying along the c-axis. This transition has been observed by others and may involve a rotation of the easy direction of magnetization away from the c-axis. This would make our model incorrect for the low temperature and would explain the apparent increase in moment with increasing temperature in the range 92K to 148K.

REPORT NO: AFML-TR-73-293 AD A000 344
ACCESS NO: 203,029 February 1974
TITLE: LIQUID CRYSTALS FOR AIR FORCE DISPLAYS
AUTHOR(S): D. Fishel
CONTRACT NO: F33615-70-C-1488
CONTRACTOR: Kent State University
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
PROJECT NO: 61102F, 7367, 736701&02
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Research was conducted toward the syntheses of new organic compounds with a general structure involving two benzene rings joined by a central group, usually polar, and with 4,4'-disubstitution of n-alkyl and n-alkoxyl groups of small polar functions such as chloro, cyano-aric acyloxy-substituents. Some members of each of the compound series involving central groups including nitrones, azines, esters, and azo- were found to possess

nematic liquid crystalline behavior. The azo- and ester series with n-alkyl and n-alkoxyl 4,4' substituents had temperature ranges just above ambient: binary mixtures of a number of these possessed nematic behavior at ambient and below ambient temperatures. Several novel compound types with gross overall structures related to the 4,4' disubstituted bisubstituted bisaryl derivatives but with intramolecular ring fusion were also prepared. In general nematic behavior in these compounds, when present, was exhibited at higher temperatures and over narrower ranges than for the open-ring analogues.

REPORT NO: AFML-TR-73-295 AD 917 408L
ACCESS NO: 202,505 January 1974
TITLE: SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES
AUTHOR(S): H. Manasevit, J. Coker, F. Pizzarello, R. Ruth
CONTRACT NO: F33615-72-C-1473
CONTRACTOR: Rockwell International
PROJECT MONITOR: R. Hickmott (AFML/LPO)
PROJECT NO: 7371
TASK NO: 737101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Composites of single-crystal thin film piezoelectric and semiconductor materials heteroepitaxially grown on insulating substrates were investigated for application to the generation, processing, and guiding of acoustic surface waves. Emphasis was on AlN as the piezoelectric material, Si as the semiconductor, and single-crystal sapphire ( $-Al_2O_3$) as the substrate; the multistrip-coupler acoustic amplifier was the device structure utilized, fabricated with films of AlN and Si deposited side-by-side on $Al_2O_3$ surfaces. AlN film growth was accomplished by the metalorganic-hydride CVD process using trimethylaluminum and ammonia; both close-space vapor transport of AlN and the $AlCl_3$-$NH_3$ reaction were also investigated for AlN deposition, but they did not produce results comparable with those of the metalorganic CVD process.

REPORT NO: AFML-TR-73-315
ACCESS NO: 202,504 February 1974
TITLE: EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS
AUTHOR(S): D. Heinz, R. Henry, F. Stearns
CONTRACT NO: F33615-73-C-5017
CONTRACTOR: Rockwell International
PROJECT MONITOR: H. Garrett (AFML/LP)
PROJECT NO: 7371
TASK NO: 737103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: In gallium-substituted iron garnets such as are used in bubble domain memories, the measured exchange constant values are lower than the normally used exchange constant values estimated from Neel molecular field theory. The measured values bring calculated wall energies into agreement with

measured wall energies. From LPE film growth studies, the growth temperature has been found to be more influential than the growth rate on the amount of lead incorporated into a film from the flux. A new garnet material containing no magnetic rare earths has been prepared which has an appreciable uniaxial anisotropy.

REPORT NO: AFML-TR-74-2
ACCESS NO: 202,426 January 1974
TITLE: MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS
AUTHOR(S): P. Jorgensen, R. Bartlett
CONTRACT NO: F33615-70-C-1624
CONTRACTOR: Stanford Research Institute
PROJECT MONITOR: J. Garrett (AFML/LP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The initial sintering kinetics of stoichiometric $SmCo_5$ powder containing a samarium-rich sintering addition have been investigated as a function of amount of liquid phase, time, temperature, and particle size. The shrinkage as a function of time exhibits the classical three stages of liquid-phase sintering; i.e., rearrangement, solution-precipitation, and solid phase. The rate-controlling step during the solution-precipitation state corresponds to a phase boundary reaction leading to dissolution. Evidence for this conclusion is based on the effect of time, temperature, and particle size on the shrinkage kinetics. The solid phase sintering kinetics of $SmCo_5$ have been investigated as functions of stoichiometry, time,and temperature. The data obtained indicate that more than one atomic transport process is operative during the solid phase sintering process, and because of this complication, the sintering mechanisms can only be tentatively identified without an assessment of their individual magnitudes.

REPORT NO: AFML-TR-74-6
ACCESS NO: 202,460 December 1973
TITLE: STUDY OF PHASE EQUILIBRIA IN THE SYSTEM Tl-As-S and Tl-As-Se
AUTHOR(S): G. Roland, J. Feichtner, J. McHugh
CONTRACT NO: F33615-72-C-1976
CONTRACTOR: Westinghouse Electric Corporation
PROJECT MONITOR: V. Donlan (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A phase diagram study was conducted to determine the melting relations in portions of the chemical systems Tl-As-S and Tl-As-Se. Particular attention was paid to composition joins such as $Tl_2S$-$As_2S_3$, $Tl_2S$-$As_2S_5$, $Tl_2S_3$-$As_2Se_3$ and $Tl_2Se$-$As_3Se_5$, joins which include the ternary compounds $Tl_3AsS_3$, $Tl_3AsS_4$, $Tl_3AsSe_3$, and $Tl_3AsS_{34}$. These compounds melt congruently and are involved in pseudobinary phase relations along the above joins. The phase diagram data were used to develop optimized crystal-growth compositions for the important ternary compounds. Crystal quality of $Tl_3AsS_3$ and $Tl_3AsS_4$ was

significantly improved during the contract period and crystals of $Tl_3AsS_3$ and $Tl_3AsSe_4$ grown for the first time. Observed features of the crystal growth were explained in terms of the observed phase relations.

REPORT NO: AFML-TR-74-17
ACCESS NO: 202,977 January 1974
TITLE: DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS
AUTHOR(S): S. Kulin, P. Neshe, K. Kreder
CONTRACT NO: F33615-73-C-5078
CONTRACTOR: ManLabs
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The compressive deformation processing of pure KCl and KCl single crystals alloyed with Eu, Rb or Br has been investigated. The variables evaluated in this IR alloy window fabrication process included temperature, total strain, strain rate, heating and cooling cycles, and quality and orientation of the single crystal starting material. Experimental conditions required to produce crack-free windows were established. Mechanical testing and microstructural observations were performed on such windows. This work has shown the feasibility of producing KCl alloy windows having high mechanical strengths. Further, processing conditions were developed which appear to establish the feasibility of scale-up for the fabrication of windows of very large sizes.

REPORT NO: AFML-TR-74-28 AD 779 719
ACCESS NO: 202,654 February 1974
TITLE: RARE EARTH COBALT SINGLE CRYSTALS
AUTHOR(S): A. Austin, J. Miller
CONTRACT NO: F33615-73-C-5038
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: R. Hutchens (AFML/LP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Single crystals of $Sm_{1-x}Pr_xCo_5$ and $Y_{1-x}Nd_xCo_5$ were grown for x = 0.25, 0.50, and 0.75. Crystals of $Gd_{0.33}Nd_{0.67}Co_5$ and $Gd_{0.5}Nd_{0.5}Co_5$ and $Sm_2Fe_{4.24}Co_{12.75}$ were also grown. The conditions for crystal growth are summarized. Data are reported on magnetic domains, unit cell lattice constants, compositions, and of inclusion phases for these systems.

REPORT NO: AFML-TR-74-30
ACCESS NO: 202,697 February 1974
TITLE: II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS
AUTHOR(S): T. Lim
CONTRACT NO: F33615-73-C-5154
CONTRACTOR: Rockwell International

PROJECT MONITOR: L. Knaak (AFML/LP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The initial work of Yim and Stofko demonstrated that good quality epitaxial films of ZnS and ZnSe could be achieved by chemical vapor phase deposition (CVD). The purpose of this work is to conduct further exploratory research using CVD aimed at elucidating optimum growth and doping conditions with the goal of producing controlled dopant characteristics. Results on dopants such as Cu, Ga, and Al are presented.

REPORT NO: AFML-TR-74-36
ACCESS NO: 202,657 March 1974
TITLE: METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE
AUTHOR(S): C. Ehrenfried
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: C. Ehrenfried (AFML/LP)
PROJECT NO: 7371
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Diffused metal-semiconductor junctions were measured and compared to a theoretical model to obtain a better understanding of the barrier mechanisms after having first formed controlled Schottky barriers. Rectifying metal contacts of gold, silver, and copper were deposited in situ on vacuum cleaved surfaces of conducting single crystal cadmium sulfide. The barrier parameters of the metal-semiconductor contact were determined from an analysis of differential capacitance and current-voltage experimental measurements. The barriers were heat-treated at various temperatures between 140C and 250C for 5 minutes. A theoretical model for a diffused metal-semiconductor barrier which included a semi-insulating layer and a linearly graded region was used to derive the capacitance-voltage relations. A parametric computer study of the model was made; the experimental data for several heat-treated barriers agreed favorably using this model.

REPORT NO: AFML-TR-74-37
ACCESS NO: 202,790 February 1974
TITLE: RESEARCH AND DEVELOPMENT ON CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS
AUTHOR(S): D. Earley, P. Franklin, R. Harris, S. Stevens
CONTRACT NO: F33615-72-C-1666
CONTRACTOR: University of Dayton
PROJECT MONITOR: P. Dimiduk (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Experimental work was conducted on the thermodynamic properties of several materials including samarium, cobalt, zinc-selenide, cadmium-telluride and mercury-cadmium-telluride. Isotopic intensities were determined on several isotopes and the results are shown graphically. The second and third law thermodynamic properties were calculated from accumulated data and the tabulated results are included. Even though the thermodynamic

properties of mercury-cadmium-telluride were not obtained, a discussion is given on some observations made during test runs and some interesting chemical analyses are shown. Several organic laser dye materials and liquid crystal materials were synthesized and investigated. The synthesis routes to these materials are detailed and the characterization results of the materials presented in tabular form.

REPORT NO: AFML-TR-74-50 AD 779 033
ACCESS NO: 202,653 March 1974
TITLE: RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS
AUTHOR(S): H. Mildrum, K. Strnat
CONTRACT NO: F33615-72-C-1795
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: D. Evans (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The principal objective of this recently concluded program was to investigate the aging stability of commercially produced sintered $SmCo_5$-based permanent magnets from two domestic sources. The results of measurements of the long-term and elevated-temperature stability of certain engineering design parameters conducted during the program are summarized and reported. Investigations were conducted on cylindrical magnet samples having length-to-diameter ratios corresponding to $B_d/H_d$ is approximately equal to 1/8, 1/4, 1,and 2-1/2.

REPORT NO: AFML-TR-74-51
ACCESS NO: 202,825 April 1974
TITLE: BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS
AUTHOR(S): M. Kenney
CONTRACT NO: F33615-73-C-5016
CONTRACTOR: Case Western Reserve University
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The use of iron phthalocyanine, PcFe, as a shift reagent for unhindered amines was further explored. In addition work with the shift reagents PcFe $(NH_2C_4H_{9-n})_2$ and PcFe $(ND_2C_4D_{9-n})_2$ was carried out. These reagents were found to be effective and easy to use reagents for unhindered amines. Also, work was done with the shift reagents PcFe $(NH_2C_6H_5)_6$ and PcFe $(ND_2C_6D_5)_6$. Of the reagents examined the latter appeared to be the best.

REPORT NO: AFML-TR-74-53
ACCESS NO: 202,865 April 1973
TITLE: FLUORINE-19 NUCLEAR MAGNETIC RESONANCE
AUTHOR(S): H. Lee, S. Lessley, R. Ragsdale
CONTRACT NO: F33615-71-C-1170

CONTRACTOR: University of Utah
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A detailed investigation of the reaction of a series of pyridines with titanium tetrafluoride has been carried out with high-resolution fluorine-19 nuclear magnetic resonance spectroscopy. Instead of the formation of only simple diaaducts a mixture of products is found in the solvent acetonitrile. Some complexes of $TiF_4$ with bidentate ligands are reported as well as some products with sulfur containing ligands. Fluorine-19 nmr data are also given for some $GeF_4 \cdot 2D$ adducts where D represents some substituted pyridine 1-oxides. Geometrical isomers were found with $GeF_4 \cdot 2D$ compounds and both first and second order nmr spectra were measured.

REPORT NO: AFML-TR-74-56 AD A000 343
ACCESS NO: 203,055 June 1974
TITLE: MERCUROUS CHLORIDE POLARIZER MATERIAL
AUTHOR(S): R. Forman, W. Brower, H. Parker
CONTRACT NO: F33615-73-M-6752
CONTRACTOR: National Bureau of Standards
PROJECT MONITOR: V. Donlan (AFML/LPJ)
PROJECT NO: PE61101F
TASK NO: JO ILIR0040
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report covers a feasibility study on the potential use of mercurous chloride crystals for construction of prism polarizers, primarily for the IR region of the spectrum. In particular,the research has consisted of crystal growth from the vapor phase and optical characterization of the absorption, dichroism, and birefringence. Crystal growth has been performed in quartz or Vycor ampoules sealed off under a pressure of $10^{-5}$ torr or better. Crystals are grown in a vertical modified Bridgman furnace by vapor transport. Repeated regrowth has been found to produce a continuous improvement in clarity, the best samples being virtually colorless. Conditions for growth have not yet been optimized, but reasonably good growing conditions have been delineated. Single crystal samples have been oriented by Laue back reflection techniques and measurements made of optical absorption, dichroism, and birefringence. Proper sample handling procedures have been determined to minimize thermal shock and thermal etching. The index of refraction has been measured at selected wavelengths, and calorimetric absorption studies performed at AFML on some of the samples produced.

REPORT NO: AFML-TR-74-57
ACCESS NO: 201,400 May 1974
TITLE: VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER
AUTHOR(S): T. Milne, J. Beachey, F. Greene
CONTRACT NO: F33615-73-C-5008

CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: P. Dimiduk (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An apparatus for producing and sampling graphite vapor was developed and studies of the vaporization of graphite were carried out. An all-graphite Knudsen cell was heated to about 3300K in vacuum without significant heating of the beam system walls or occurrence of objectionable outgassing. A continuously operating vacuum viewport and automatic pyrometer system allowed temperature monitoring under rapid window darkening conditions produced during vaporization runs. An extensive experimental determination of the neutral time-of-flight behavior of both carbon and low temperature gaseous species was carried out. Anomalous results were obtained which indicated either slow neutrals in the beam or major ion trapping in the nuclide ion source. Experiments in which the nuclide ion source is operated in the pulsed mode seem to establish that many of the "delayed" ions are actually coming from slow neutrals, but the phenomenon is not completely understood.

REPORT NO: AFML-TR-74-82 AD 783 295
ACCESS NO: 202,864 June 1974
TITLE: ACOUSTIC DELAY LINES
AUTHOR(S): H. Huang, J. Knox, J. Rosen, Z. Turski, R. Wargo
CONTRACT NO: F33615-73-C-5014
CONTRACTOR: RCA Laboratories
PROJECT MONITOR: R. Hickmott (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this program is to develop the basic technology required for fabrication of low-loss, broadband acoustic delay lines at microwave frequencies. During this program period, we have developed a technology for fabrication of multioctave $LiNbO_3$/spinel delay lines for use at frequencies as high as X-band. As a result of the progress made in this program, the feasibility of producing multioctave acoustic delay lines has been demonstrated. These acoustic delay lines not only serve as a replacement of the heavier and bulkier electromagnetic wave delay lines but also make possible some new system implementations such as digitally switchable delays for coherent memory systems.

REPORT NO: AFML-TR-74-87
ACCESS NO: 202,968 May 1974
TITLE: RESEARCH IN THE PRODUCTION OF RARE-EARTH-COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION
AUTHOR(S): R. Allen, S. Dahlgren, H. Arrowsmith, J. Heinrich
CONTRACT NO: F33615-73-C-5012
CONTRACTOR: Battelle/Northwest
PROJECT MONITOR: H. Garrett (AFML/LP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Substantial progress has been made in developing high-rate sputter deposition as a technique for producing fine-grained, low-oxygen

rare-earth-cobalt (R-Co) magnet material for research purposes and in the thicknesses, shapes, and with the mechanical and magnetic properties required for critical permanent magnet applications. Studies conducted demonstrate that thick $RCo_5$ and $R_2(Co,Fe)_{17}$ sputter deposits can be routinely prepared containing less than 0.10 wt% oxygen. The low oxygen content of the sputtered R-Co alloys enhances the mechanical properties, fabricability, and magnetic properties of the resulting magnet material by minimizing internal oxide formation and the precipitation of cobalt-rich phases. The present studies further show that high-rate sputter deposition has definite potential as a manufacturing technique for thin-section R-Co permanent magnets. Complex magnet shapes can be fabricated directly to high tolerances from the low-oxygen amorphous magnet material using conventional machining techniques.

REPORT NO: AFML-TR-74-110
ACCESS NO: 203,161 June 1974
TITLE: PHOTOCHEMICAL STUDIES ON ORGANIC LASERS
AUTHOR(S): R. Srinivasan, R. von Gutfeld, C. Angadiyavar, E. Tynan
CONTRACT NO: F33615-73-C-5080
CONTRACTOR: International Business Machines
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The fluorescence emission from alcoholic solutions of 7-monoalkylamino-4-methyl coumarins shifts from blue to blue-green on the addition of acid. Fluorescence and excitation spectra measured at various concentrations show that with increasing concentration, a new excitation peak appears which is the source of the blue-green emission in the presence of acid. It is suggested that this new species is a dimer of the coumarin. The analyses of the amplified fluorescence spectra with a streak camera indicate that the blue-green emission is due to a transient excited species, consistent with a model based on the addition of $H^+$ to the excited dimeric state. New laser dyes based on the coumarin skeleton have been synthesized by varying the substituent groups at the 3- and 7- positions. New laser dyes of the pyridine class were also synthesized. These were effective in the violet region of the spectrum.

REPORT NO: AFML-TR-74-113
ACCESS NO: 202,981 June 1974
TITLE: PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS
AUTHOR(S): R. Lin, W. Smith, J. Coppola, J. Economy
CONTRACT NO: F33615-73-C-5110
CONTRACTOR: The Carborundum Company
PROJECT MONITOR: M. Ohmer (AFML/LPO)
PROJECT NO: 62102F
TASK NO: 73710324
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Niobium carbonitride yarn consisting of 720 filaments with a fiber diameter of 6 to 7 microns was consistently prepared to possess an

optimum composition. The preparation was accomplished by reacting the carbon fiber precursor with niobium pentachloride in the presence of hydrogen and nitrogen at 1500 to 1600C for 2 to 6 minutes. The reacted yarn was quenched from the reaction temperature to about 200C to retain the niobium carbonitride phase. The thickness of the reaction layer, which consisted of both niobium carbonitride and niobium carbide phases, was in the range of 0.4 to 1.0 micron. A post treatment with ammonia was found to cause a composition change yielding a nitrogen rich product via a further nitriding process. The improvement of critical contact of the copper coating on the niobium carbonitride yarn was accomplished by a post-coating heat treatment in the temperature range of 600 to 1000C in the inert atmosphere.

REPORT NO: AFML-TR-74-126
ACCESS NO: 202,890 July 1974
TITLE: Nd-DOPED MIXED CRYSTAL LASER MATERIAL RESEARCH
AUTHOR(S): W. Holton, D. Bellavance, F. Bruni, M. deWit, R. Watts
CONTRACT NO: F33615-72-C-1977
CONTRACTOR: Texas Instruments Incorporated
PROJECT MONITOR: V. Donlan (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The mixed crystal system $Y_3(Al_xGa_{1-x})_5O_{12}$ was investigated as a laser host material for Nd3+. Spectroscopic studies established that at the optimum composition a reduction by a factor of 3 in gain, as compared with YAlG($Y_3Al_5O_{12}$), is possible, implying increased output energy in Q-switched operation. Mechanical and thermal properties were found to be similar to those of YAlG. Laser rods were fabricated from boules of the material, examined for optical quality, and tested under Q-switched conditions. The poor optical quality of the material, due largely to iridium inclusions and strain, precluded quantitative measurement of intrinsic laser parameters and a definitive comparison with YAlG. It is concluded that although the mixed crystal material has potential advantages, it is not possible to realize this potential because of the difficulty of growing crystals of high optical quality.

REPORT NO: AFML-TR-74-146
ACCESS NO: 203,082 September 1974
TITLE: SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED-ARRAY ANTENNAS
AUTHOR(S): J. Van Hook, J. Green
CONTRACT NO: F33615-72-C-1524
CONTRACTOR: Raytheon Research Division
PROJECT MONITOR: W. Frederick (AFML/LPO)
PROJECT NO: 7371
TASK NO: 737103
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Lithium ferrite materials for avionic phased-array applications at Ku- and X-band were developed by using conventional methods of ceramic

processing and firing. Composition variables of Mn, Ti, and Co substitution were used to adjust the magnetic properties to the intended use. Bismuth oxide additions in the range of 0-0.2 wt.% were used to alter the sintering and grain growth characteristics. Correlations were made between the resulting microstructures and structure sensitive magnetic properties. The stress sensitivity was determined on dense ceramics for different magnetizations and as a function of Mn and Co content. The Co concentration and not Mn was found to be the determining factor. Where single-crystal data were available, correlation was found between sign and magnitude in stress sensitivity and in the anisotropy constant K1. The correlation of stress dependence and the single crystal magnetostriction coefficients was only weakly apparent.

REPORT NO: AFML-TR-74-156 AD A002 135
ACCESS NO: 203,191 August 1974
TITLE: $RCo_5$ COERCIVITY
AUTHOR(S): C. Wearle, H. Garrett
CONTRACT NO: F33615-73-C-5020
CONTRACTOR: internal
PROJECT MONITOR: H. Garrett (AFML/LP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Hysteresis loops associated with single crystals of $Nd_{(1-x)}Sm_xCo_5$ were experimentally investigated. The results of this investigation led to a theoretical model which could describe the experimental data. The model was further refined and checked which put it on firm experimental grounds. The state-of-the-art production process for $SmCo_5$ sintered permanent magnets was analysed in terms of the model. An alteration of the production process is presented which could result in better permanent magnets.

REPORT NO: AFML-TR-74-162
ACCESS NO: 203,350 November 1974
TITLE: NARROW GAP SEMICONDUCTORS--PbSnTe and PbSnSe
AUTHOR(S): T. Tao
CONTRACT NO: MIPR FY145773N00002
CONTRACTOR: Naval Post Graduate School
PROJECT MONITOR: R. Hickmott (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A variety of studies were carried out on evaporated thin films of PbSnTe and PbSnSe by Prof. T. F. Tao and his thesis students. This report is a collection of the resulting publications as follows: "Feasibility Study of PbTe and PbSnTe Infrared Charge Coupled Imager," "Study of the Refractive Indices of PbSnTe," "Pb-Sn Chalcogenide Alloy Thin Film Photoconductive Detectors," "Study of PbSnTe Heterojunctions," and "Effects of Proton Bombardments and Their Isochronal Annealings in PbTe and PbSnTe."

REPORT NO: AFML-TR-74-165
ACCESS NO: 201,786 August 1974
TITLE: CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH-POWER, IR LASER WINDOWS

AUTHOR(S): E. Shrader
CONTRACT NO: F33615-72-C-2160
CONTRACTOR: Harshaw Chemical Company
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The work reported is divided in two phases. During the first phase the development of a suitable window material for high power lasers operating at 10.6 m was undertaken. The development was based on the production of divalent ion doped polycrystalline KCl with the required mechanical and optical properties. The results of this development program are reported in this report. The second phase provided for the growth of a number of KCl alloy crystals for use of the Air Force Materials Laboratory. In addition, a number of pure and europium doped KCl crystals were also supplied.

REPORT NO: AFML-TR-74-166 Part I
ACCESS NO: 203,307 October 1974
TITLE: OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH-POWER LASER APPLICATIONS
AUTHOR(S): J. Kurdock
CONTRACT NO: F33615-73-C-5127
CONTRACTOR: Perkin-Elmer Corporation
PROJECT MONITOR: J. Fenter (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The Optical Processing of Alkali Halides and Polycrystalline Zinc Selenide for High-Power Laser Applications is a program designed to investigate the optical fabrication, optical coating, and characterization of alkali halide and zinc selenide materials for high-powered laser windows. The program is divided into two phases. The first phase was the investigation of substrates of Raytheon's CVD zinc selenide. The second phase of the program is the extension of the successful coating and polishing techniques to polycrystalline potassium chloride and doped substrates of potassium chloride. As a result of the zinc selenide effort, substrates up to 14 cm. in diameter have been polished and coated with durable antireflective film systems with total optical losses of less than 0.1. The final work on zinc selenide has been completed and work is now underway on substrates of potassium chloride.

REPORT NO: AFML-TR-74-186
ACCESS NO: 203,184 August 1974
TITLE: ALUMINUM NITRIDE FOR SURFACE ACOUSTIC WAVES
AUTHOR(S): K. Lakin
CONTRACT NO: F33615-74-C-5040
CONTRACTOR: University of Southern California
PROJECT MONITOR: R. Hickmott (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Aluminum nitride films of single crystal quality have been grown upon single crystal R-plane sapphire substrates. It was demonstrated that

AlN could also be grown upon another AlN film that had been polished. In this manner thick films of 10 microns thickness or greater could be obtained. Scanning electron microscopy was used to evaluate the as-grown film morphology and show the microstructure orientation coherence. The surface acoustic wave properties of the film were measured out to a film thickness to wavelength ratio of 0.75. Maximum K2 of 0.8% was obtained with velocity of 6KM/sec at a thickness to wavelength ratio of 0.3 for propagation along the AlN c-axis.

REPORT NO: AFML-TR-74-190
ACCESS NO: 203,267 September 1974
TITLE: STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS
AUTHOR(S): M. Labes, A. Baise
CONTRACT NO: F33615-72-C-1441
CONTRACTOR: Temple University
PROJECT MONITOR: R. Rondeau (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A number of electro-optic effects in liquid crystals of importance in display applications have been studied. Several new stable nematic liquid crystals were synthesized for possible use in dynamic scattering, and the threshold for scattering in an azoxy-type liquid crystal was lowered significantly by the use of charge-transfer acceptors as dopants. These dopants were also used to produce scattering in a liquid crystal having a positive dielectric anisotropy. The effect of large changes in dielectric anisotropy on twisted nematic devices has been examined, and significant improvements in the decay times for the effect were achieved by using a two-frequency addressing mode. Studies on the electric field-induced cholesteric-nematic transition have shown that a non-uniform distortion of the cholesteric helix occurs under certain conditions.

REPORT NO: AFML-TR-74-205
ACCESS NO: 203,208 September 1974
TITLE: SYNTHESIS AND CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS
AUTHOR(S): R. Bertke, J. Henes, R. Jones, C. Searle
CONTRACT NO: F33615-73-C-5020
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: R. Spry (AFML/LPO)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report covers research on rare-earth magnetic materials and the electrical and optical properties of semiconductors. Studies were made of the magnetization reversal process in RCo5 particles and sintered permanent magnets and experimental verification of a model for the magnetization reversal in RCo5 particles was conducted. Research studies were conducted on both the optical and electrical properties of defect centers in semiconductors. A wavelength modulation spectrometer was designed to investigate the electrical characteristics of defects in $Hg_xCd_1Te$ and other semiconductors.

AFML/LP

REPORT NO: AFML-TR-74-235
ACCESS NO: 203,329 December 1974
TITLE: EXPLORATORY DEVELOPMENT ON LASER AND OPTICAL MATERIALS
AUTHOR(S): J. O'Hare, J. Detrio, R. Petty, P. Yaney
CONTRACT NO: F33615-73-C-5009
CONTRACTOR: University of Dayton
PROJECT MONITOR: V. Donlan (AFML/LPJ)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Theoretical studies were initiated whereby, given a limited amount of spectroscopic data of trivalent rare earth ions in transparent crystals, complete Stark energy level schemes, J-mixed crystal field state vectors, spontaneous emission probabilities between Stark components of J manifolds, branching ratios, and quantum efficiencies could be generated. Extension of the Judd-Ofelt theory to transitions between Stark components and identification of basic parameters which determine laser transitions are discussed. The possibility of these calculations being used to predict optimum ion-host combinations for laser transitions in a practical, efficient, and inexpensive manner is also discussed.

REPORT NO: AFML-TR-74-253 AD B001 011L
ACCESS NO: 203,334 November 1974
TITLE: RESEARCH ON $YB_{66}$ FOR MICROWAVE ACOUSTIC CRYSTALS
AUTHOR(S): G. Slack, J. Young, W. Knapp, D. Oliver, G. Brower
CONTRACT NO: F33615-71-C-1531
CONTRACTOR: General Electric Company
PROJECT MONITOR: R. Hickmott (AFML/LPO)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report summarizes the results of three years of work on the problems of producing crystals and crystal plus transducer assemblies for long memory time, microwave ultrasonic delay lines. Information on sapphire, spinel, yttrium aluminum garnet, and yttrium boride is presented. At present, magnesium aluminate spinel appears to be the best available material for delay lines. It has low acoustic attenuation and low diffraction losses. Transverse acoustic waves are required in spinel in order to take advantage of its low-loss characteristics. Shear mode transducers of X-cut lithium niobate are suitable for generating these waves. Calculations show that losses in the transducer-to-delay line bond can be held to a minimum by using an alloy of gold, paladium, and silver. This was not verified experimentally. The borides of yttrium are not suitable at present for delay lines because of problems with crystal growth and an anomalous acoustic attenuation that appears to be closely associated with the crystal chemistry.

MANUFACTURING TECHNOLOGY DIVISION (AFML/LT)

REPORT NO: AFML-TR-73-251 AD 917 815
ACCESS NO: 202,542 November 1973
TITLE: MANUFACTURE OF BERYLLIUM STRUCTURES
AUTHOR(S): J.P.Denny, R.H. Burns, R.C. Solbach
CONTRACT NO: F33615-73-C-5081
CONTRACTOR: Kawecki Berylco Industries, Inc.
PROJECT MONITOR: G. Glenn, L. Clark (AFML/LTM)
PROJECT NO: 277-3
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this program was to transfer the hot-isostatic pressing (HIP) technology of beryllium from laboratory to production facilities, and to manufacture and characterize several structural components produced from high purity 325 mesh P-1 type beryllium powder for use on a SAMSO-funded program at McDonnell-Douglas Astronautics Co. Two full-size forward frustum shells, two Breechlock joint test pieces, and one upper half of a frustum shell were produced. In all cases impurity levels were low and mechanical properties exceeded 63 ksi UTS, 36 ksi YS and 3.1% elongation. The forward frustums and breechlock test pieces were shipped to McDonnell-Douglas for additional processing and testing.

REPORT NO: AFML-TR-73-287
ACCESS NO: 201,539 October 1973
TITLE: MANUFACTURING PROCESSES FOR 20mm (M103) ALUMINUM ALLOY CARTRIDGE CASES
AUTHOR(S): H.F. Boekhoff
CONTRACT NO: F33615-72-C-1719
CONTRACTOR: Martin Marietta Aluminum
PROJECT MONITOR: R. Kennard (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report describes a program to establish impact extrusion as the manufacturing process to produce 20mm aluminum alloy (M103) cartridge cases that will function in the M61 and M-39 systems. Satisfactory performance in the M61 gun has been demonstrated at both contractor and LCAAP test firings, with cartridge cases produced in aluminum alloy 7075-T76 condition. Rim shear has occurred in the M-39 gun with standard anodized 7075-T76 cases. At LCAAP test firings, 7075-T76 aluminum alloy cartridge cases coated with a special Teflon-anodize functioned satisfactorily in this gun. Three separate manufacturing processes, employing aluminum alloy impact extrusion techniques ,were investigated in the effort to solve M-39 gun extraction problems. They were the headed process, impact rim process, and headless process. The basic impact extrusion method has demonstrated the capability for high production. The aluminum 20mm cartridge case offers a 65% weight saving over the brass case and a 30% weight reduction over the assembled M55 cartridge.

AFML/LT

REPORT NO: AFML-TR-73-298 AD 917 536L
ACCESS NO: 69,924 February 1974
TITLE: MANUFACTURING PROCESS FOR THE PRODUCTION OF TAPERED TITANIUM ALLOY PLATE
AUTHOR(S): G. Lenning
CONTRACT NO: F33615-71-C-1513
CONTRACTOR: Titanium Metals Corporation of America
PROJECT MONITOR: L. Clark (AFML/LTM)
PROJECT NO: 200-1
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report covers processing and testing of a manufacturing process program to evaluate a method for production of flat rolled material having a tapered thickness from end to end. The method evaluated employed hot rolling with an offset roll to produce a tapered thickness. This report describes fabrication of the tapered thickness by hand and machine feeding the rolls, development of processing procedures, and evaluation of materials produced.

REPORT NO: AFML-TR-73-301
ACCESS NO: 200,233 February 1974
TITLE: IMPROVED MANUFACTURING METHODS FOR PRODUCING HIGH INTEGRITY, MORE RELIABLE TITANIUM FORGINGS
AUTHOR(S): R.B. Sparks, J.R. Long
CONTRACT NO: F33615-71-C-1560
CONTRACTOR: Wyman-Gordon Company
PROJECT MONITOR: N. Klarquist (AFML/LTP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This program was aimed at the determination of the effect of certain macro and microstructural variations on the mechanical properties of Ti-6Al-4V, Ti-6Al-6V-2Sn, and Ti-6Al-2Sn-4Zr-6Mo forgings. Smooth and notched tensile, smooth and notched high cycle fatigue, low cycle fatigue, and fracture toughness properties were established for each structure. The microstructures of all conditions as observed by optical microscopy are presented and described. Fracture patterns of the fracture toughness bars are characterized by scanning electron micrographs. A mechanical property rating system which may be used to compare the various conditions evaluated is described. A third task involved the effect of certain metallurgical flaws on the mechanical properties of the Ti-6Al-4V and Ti-6Al-6V-2Sn alloys.

REPORT NO: AFML-TR-73-307 AD 918 033L
ACCESS NO: 200,397 February 1974
TITLE: IMPROVED AUTOMATED TAPE LAYING MACHINE
AUTHOR(S): M. Poullos, W. J. Murray, D.L. Norwood, B.W. Staff
CONTRACT NO: F33615-72-C-1009
CONTRACTOR: LTV Aerospace Corporation

PROJECT MONITOR: P. Pirrung (AFML/LTN)
PROJECT NO: 989-1
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this program was to develop manufacturing methods for the production of high modulus composite structures by numerically controlled tape machine automation. The Phase I effort describes the critical importance of the machine/tape material interface. The principal task of the Phase II effort was to design and install an interchangeable N/C controlled NDT/NDI head comprised of "off the shelf" equipment items. The Phase III accomplishments presented include the tape machine production demonstration of three graphite and three boron/epoxy A-7D wing skins. These skins were also inspected by the NDT/NDI head after cure and machining.

REPORT NO: AFML-TR-73-308
ACCESS NO: 202,923 January 1974
TITLE: PROJECTION MASKING SYSTEM EVALUATION
AUTHOR(S): J.W. Bossung
CONTRACT NO: F33615-73-C-5035
CONTRACTOR: Perkin-Elmer Corporation
PROJECT MONITOR: E. Miller (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A task structure was established to accomplish the evaluation. The results are summarized as follows: (a) mask requirements, (b) wafer requirements, (c) photoresist tests, (d) industry acceptance, (e) system test data, and (f) depth of focus.

REPORT NO: AFML-TR-73-314
ACCESS NO: 69,987 January 1974
TITLE: AUTOMATION OF COATING PROCESSES FOR GAS TURBINE BLADES AND VANES
AUTHOR(S): H.A. Fisch
CONTRACT NO: F33615-71-C-1593
CONTRACTOR: TRW Inc.
PROJECT MONITOR: J. Williamson (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: During the first quarterly report period, laboratory procedures were established for using aqueous suspensions for electrophoretically depositing bisques of coating source materials onto nickel-base superalloys for three coating/substrate systems. These systems and the corresponding commercial or conventional coating analogues (in parentheses) are: Al-Si/B-1900 (Jo-Coat), Al-Ti plus $Al_2O_3$/IN-100 (CODEP), and Mn modified Al/Cr/B-1900 (vacuum pack process). Parameters were also established for heat treating these bisques in either vacuum, hydrogen or argon to form aluminide coatings.

AFML/LT

REPORT NO: AFML-TR-74-4 AD 917 410L
ACCESS NO: 200,395 January 1974
TITLE: PRODUCTION PROCESSES FOR COMPOSITE TAPES
AUTHOR(S): R.G. Carlson
CONTRACT NO: F33615-71-C-1646
CONTRACTOR: AVCO Corporation
PROJECT MONITOR: C. Anderson (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report describes the Phase I and Phase II efforts on a program to refine processes and scale-up procedures to increase the production rate, lower the product cost, and improve the quality of monolayer boron/aluminum tape formed by the continuous roll binding (CRB) process. In Phase I process parameter studies, which were subjected to statistical analyses, established selected conditions for producing high quality tape for several filament/matrix combinations. Evaluation emphasis was placed on two principal filament matrix combinations, 50 v/o 5.6 mil B/2024 Al and 50 v/o 5.6 mil B/6061 Al. Consolidated panels made from CRB tape exhibited excellent strength properties which met the required goals. Fabrication of long lengths of 3-inch wide boron/acrylic tape is described. In Phase II the fabrication of CRB was evaluated to determine the advantages and disadvantages compared with other tape materials.

REPORT NO: AFML-TR-74-7 AD 920 193L
ACCESS NO: 202,858 February 1974
TITLE: FABRICATION TECHNIQUES FOR RIVET FASTENERS UTILIZING 55-NITINOL
AUTHOR(S): W. Schwenk
CONTRACT NO: F33615-72-C-1190
CONTRACTOR: Grumman Aerospace Corporation
PROJECT MONITOR: H. Johnson (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Three ingots of different nitinol alloy compositions were melted, hot rolled and either cold rolled plus annealed or hot wire drawn down to diameters of 0.401, 0.272, and 0.167 inch. Based on mechanical property comparisons, cold rolled ingot V4758 material, which contained 6.6% cobalt, was selected as the optimum nitinol alloy. Extrusion and fette-type rolling were investigated to determine their suitability to deform fastener blanks to the intermediate shape. The Hi-Lok fastener was selected as the optimum configuration as the result of an evaluation of four major fastener designs. The Hi-Lok fastener was used in the structural integrity tests because of its unique, controllable radial expansion characteristic and because it did not have the potential tensile and formability shortcomings of the other configurations evaluated. Mechanical property tests showed that nitinol fasteners were comparable to Taper-Lok fasteners in aluminum alloy joints but inferior to A286 stainless steel rivets in titanium alloy joints.

REPORT NO: AFML-TR-74-10, Vol.I AD 919 993L
ACCESS NO: 201,121 February 1974
TITLE: SLEEVE COLDWORKING FASTENER HOLES. VOLUME I: DISCUSSION AND SUMMARY
AUTHOR(S): J.L. Phillips
CONTRACT NO: F33615-72-C-1630
CONTRACTOR: Boeing Commercial Airplane Co.
PROJECT MONITOR: C. Silha (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Optimized process parameters for sleeve coldworking of fastener holes have been developed, and the effects of process and application parameters on structural performance have been defined for selected aluminum, titanium, and high strength steel alloys. The sleeve coldworking process for fastener holes in a process that uses a tapered mandrel in conjunction with a disposable, prelubricated sleeve to compressively prestress a significant size zone around each hole which offsets the stress concentration of the hole itself. The sleeve method allows higher degrees of prestressing than possible with other methods and offers potential for significant improvements in fatigue performance. In addition, it does not require precision controls germane to other fatigue rated hole preparation/fastener installation systems. This technical report covers the results of this 21 month program. In addition to definition of optimized methods and the effects of process and application variations upon structural performance, the results include performance and economics comparisons for the process with other fatigue-rated hole preparation/fastener systems. Volume II contains test data sheets and other supporting data.

REPORT NO: AFML-TR-74-14 AD 917 709L
ACCESS NO: 200,232 January 1974
TITLE: MANUFACTURING METHODS FOR FILAMENTARY REINFORCED TITANIUM MONOTAPES
AUTHOR(S): G.S. Doble, P. Melnyk, I.J. Toth
CONTRACT NO: F33615-71-C-1690
CONTRACTOR: TRW, Incorporated
PROJECT MONITOR: C. Anderson (AFML/LTN)
PROJECT NO: 283-1
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A manufacturing process has been established for the production of 6-in. wide by 15-ft. long filamentary reinforced titanium matrix monotapes. Composite systems including 5.6 mil boron, 5.7 mil borsic, and 4 mil silicon carbide filaments with Ti-6Al-4V, Ti-3Al-2.5V, Beta III, and Ti(A55) matrix foils were evaluated for fabricability and properties using small test panels. Bonding times as low as 5 minutes were successfully employed in a rapid vacuum press bonding cycle. Borsic-Ti (6Al-4V) and boron-Ti (3Al-2.5V) were selected for manufacturing scaleup. Borsic Ti (6-4) strength levels ranged from 170 to 206 ksi longitudinal with an average transverse strength of 75 ksi after scaleup. The boron-Ti (3-2½) system had lower properties with 150-160 ksi being typical of longitudinal tensile strength and 65-70 ksi transverse strength. Manufacturing scaleup included an increase in pack quantity to 25 monotapes and increase in length to the 6-in. by 15-ft. size. Mechanical properties of the resultant composite were determined.

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REPORT NO: AFML-TR-74-20 AD 917 386L
ACCESS NO: 90,559 March 1974
TITLE: PEEN FORMING TITANIUM PANELS
AUTHOR(S): W.W. Brandel, D.C. Patton
CONTRACT NO: F33615-72-C-1075
CONTRACTOR: AVCO Corporation
PROJECT MONITOR: J. Williamson (AFML/LTM)
PROJECT NO: 788-1
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This is the final technical report pertaining to the "Peen Forming of Titanium" manufacturing technology program. The program was accomplished in three distinct phases. In Phase I, small Ti-6Al-4V test panels were formed and evaluated in order to determine the effects of process factors on contour; and to establish data for generating methods of predicting contour as a function of forming parameters. In Phase II, the effectiveness of the derived prediction methods was verified by using them to predict the contour in several larger panels, and comparing the actual results with the predicted values. Prediction methods were further verified in Phase III by forming a simulated aircraft wing skin panel to within 10.4% of values predicted at 10 out of 13 contour check stations. Considering the complexity of the wing panel configuration, this degree of accuracy is considered quite good. The overall panel geometry was that of an inboard end section. Its thickness tapered linearly inboard to outboard, and there were sculptured membrane areas, edge reinforcements, faying surfaces,and a hold representing an access opening.

REPORT NO: AFML-TR-74-24
ACCESS NO: 203,108 April 1974
TITLE: MANUFACTURING METHODS FOR COS/MOS MEMORY
AUTHOR(S): W.A. Bosenberg
CONTRACT NO: F33615-71-C-1085
CONTRACTOR: RCA Solid State Division
PROJECT MONITOR: J. Garrett (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: Manufacturing processes for the fabrication of hermetically sealed, beam-lead COS/MOS devices coupled with high-density packaging techniques have been established. Extensive work was done in the area of thin-film metallization on ceramic substrates to interconnect COS/MOS devices. Various components of a full 8192-byte memory system have been developed. A 256-bit, COS/MOS random-access memory (RAM) chip employing sealed-junction, beam-lead technology has been developed and small quantities have been fabricated. Despite extensive effort, difficulties encountered in the fabrication and bonding of the COS/MOS memory chip prevented the assembly of a sufficient number of these devices to populate the memory-storage plane. It is believed that these problems are directly related to the aggressive layout rules used in the design of this chip.

AFML/LT

REPORT NO: AFML-TR-74-27
ACCESS NO: 200,986 January 1974
TITLE: IMPROVED TAPE LAYING MACHINE
AUTHOR(S): G.F. Van Y
CONTRACT NO: F33615-72-C-1652
CONTRACTOR: General Dynamics
PROJECT MONITOR: P. Pirrung (AFML/LTN)
PROJECT NO: 898-1
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The accomplishments documented by this report represent the sequence of events leading up to the successful demonstration of an Improved Tape Laying Machine. The existing Conrac TLM-100 tape layer was used as the basis for development of several new systems related to tape laying. The tape laying process was improved by the development of a new delivery head. The quality control function was simplified by the adaptation of a continuous inspection device for monitoring material quality being used to fabricate composite laminates. Detailed explanations and illustrations are made to document these developments.

REPORT NO: AFML-TR-74-46 AD 920 248L
ACCESS NO: 69,473 August 1974
TITLE: IMPROVEMENT OF TITANIUM ALLOY INGOTS BY SOLIDIFICATION CONTROL
AUTHOR(S): F.W. Wood
CONTRACT NO: F33615-71-M-5005
CONTRACTOR: Albany Metallurgy Research Center
PROJECT MONITOR: R. Kennard (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The goal of this new two-year program is to improve the quality and uniformity of titanium alloy ingot structures through manufacturing process modifications that effect greater control of conditions as ingot metal freezes. A new furnace is being designed for use in the main part of the work. Meanwhile, some exaggerated grain boundaries, and veins of both alpha and beta stabilized material in ingots and billets have been briefly investigated. Each of these types of irregularities might be related to solidification conditions.

REPORT NO: AFML-TR-74-59 AD 920 295L
ACCESS NO: 202,689 April 1974
TITLE: MANUFACTURING METHODS FOR SPIRAL WELDED TITANIUM TUBING
AUTHOR(S): W.P. McGreagor, B.G. Bailey
CONTRACT NO: F33615-72-C-1331
CONTRACTOR: International Harvester Company

PROJECT MONITOR: F. Miller (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The objective of this contract was to demonstrate that welding of spiral wrapped titanium alloy strip can be utilized to produce high quality, cost-effective tubing that can be swaged or drawn and bent into forms usable in aerospace applications. Techniques were developed for fabrication of two-foot lengths of tubing in two diameters-wall thickness combinations. Both Ti-6Al-4V and Ti-3Al-2.5V alloys were used. All tubes were formed by the same method of wrapping at room temperatures around solid mandrels on which they were subsequently annealed in the tightly formed condition. Three welding methods were employed for each combination of alloys and tube diameters. Satisfactory results were obtained by each welding method as determined by visual, ultrasonic, radiographic, fluorescent penetrant, and metallographic examination.

REPORT NO: AFML-TR-74-60
ACCESS NO: 202,760 April 1974
TITLE: SURFACE INTEGRITY OF MACHINED MATERIALS
AUTHOR(S): W. P. Koster
CONTRACT NO: F33615-72-C-1385
CONTRACTOR: Metcut Research Associates Inc.
PROJECT MONITOR: W. Harris (AFML/LTM)
DIST. STATEMENT: A basic surface integrity evaluation has been completed on 17-4PH, Ti-6Al-4V, Rene' 41, MAR-M509, and Al 7075. Variations in grinding caused each alloy to display a broad range of surface integrity characteristics. Other metal removal processes generally produced surface integrity levels falling within the bounds provided by the extremes of grinding. A detailed study on the effect of surface finish variations in both milling and grinding was carried out. In all cases, surface finish variations caused little effect on surface integrity. The effect of post-processing on improving surface integrity was also evaluated for a number of significant processes. A statistical evaluation of the relation between grinding parameters, surface integrity, and productivity was completed. A regression analysis identified conditions which were experimentally demonstrated to produce optimum levels of surface integrity concomitant to reasonably high productivity. Production simulation programs have confirmed that machining processes carried out on large production equipment duplicate surface integrity results produced in the laboratory.

REPORT NO: AFML-TR-74-68 AD 919 880L
ACCESS NO: 200,231 January 1974
TITLE: MANUFACTURING PROCESS FOR LUBRICATING COMPOSITES
AUTHOR(S): J.W. VanWyk
CONTRACT NO: F33615-71-C-1542
CONTRACTOR: Boeing Aerospace Company
PROJECT MONITOR: D. Starks (AFML/LTP)

DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: A hot isostatic manufacturing process for fabricating solid lubricant composite materials containing molybdenum disulfide, tantalum, and molybdenum was investigated. Powders used in composite fabrication were characterized by particle size, bulk density, surface area,and shape. An experimental design which included an evaluation of eleven different processing variables was conducted. An analysis of test data showed that the flexural and crushing strengths of all compositions decreased with calendar time. A correlation was established between the reduction in physical strength properties and the percentage of molybdenum in each composition. A chemical analysis of the molybdenum showed that the oxygen content of the powder had increased by 800% from the beginning to the end of the program. Due to the apparent influence of oxidized molybdenum powder, work on the program as originally planned was discontinued. A redirected program to fabricate materials from uncontaminated powders in an ultra clean atmosphere free from oxygen was outlined. This investigation was not pursued.

REPORT NO: AFML-TR-74-69 AD 921 397
ACCESS NO: 201,821 March 1974
TITLE: IMPROVED GRAPHITE REINFORCED TAPE
AUTHOR(S): R.E. Randolph, N.A. Alberts
CONTRACT NO: F33615-72-C-1236
CONTRACTOR: Hercules Incorporated
PROJECT MONITOR: D. Starks (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This report concludes the work to establish an improved method for the manufacture of 500 ft long splice free graphite epoxy preimpregnated tape suitable for use on numerically controlled tape laying machines. Candidate processes were evaluated and the one selected was a Hercules-funded tape line modification that employed hot melt impregnation techniques. This approach resulted in improved fiber collimation, resin content control, tack, thickness control, reduced volatiles, splicing methods, and width control. The composite system selected for process optimization and production demonstration purposes consisted of Hercules 3501/AS graphite epoxy components. Other requirements satisfactorily met were: Quality assurance measures were established, preliminary specifications covering product procedures were submitted, and an economic evaluation of the prepreg manufacturing process was conducted.

REPORT NO: AFML-TR-74-70 AD 920 253L
ACCESS NO: 201,739 May 1974
TITLE: MANUFACTURING METHODS FOR DIMENSIONALLY STABLE COMPOSITE MICROWAVE COMPONENTS
AUTHOR(S): L.B. Keller, H. Raech
CONTRACT NO: F33615-72-C-1933
CONTRACTOR: Hughes Aircraft Company
PROJECT MONITOR: C. Tanis (AFML/LTF)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The object of this program was to establish manufacturing methods to allow the quantity production of dimensionally stable microwave

components from graphite-fiber reinforced composites. These components were to have electrical performance equal to or better than that of conventional metal components. All of these microwave components were successfully produced and tested. The manufacturing methods selected to produce the GFRP shapes were: autoclave curing of band wrapped tubular shapes, compression molding of complex configurations, and press laminating of flat pieces. In all cases the GFRP parts were lighter than their metallic counterparts. Cost projections indicate that GFRP filters are more economical to produce than brazed Invar assemblies.

REPORT NO: AFML-TR-74-72 AD 921 896L
ACCESS NO: 200,654 March 1974
TITLE: STRUCTURAL FABRICATION GUIDE FOR ADVANCED COMPOSITES
AUTHOR(S): L.E. Meade
CONTRACT NO: F33615-72-C-1215
CONTRACTOR: Lockheed-Georgia Company
PROJECT MONITOR: H. Reinert (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: This program, which establishes a production manufacturing guide for advanced composite structures, included (1) production analysis, (2) process/cost interrelationships, and (3) establishment of process selection techniques. A Fabrication Guide was developed from the vast consortium of information generated by the many programs that have been conducted to develop advanced composite technology, and compiles this information in a synergistic fashion to assist the dissemination of this technology throughout the industry. Details of the efforts performed to (1) determine and organize a useful guide format, (2) acquire selected and overall manufacturing information, (3) establish an automatic Data Retrieval System for information arrangement and evaluation, and (4) publish a preliminary edition of the guide are included.

REPORT NO: AFML-TR-74-81 AD 919 551L
ACCESS NO: 69,791 March 1974
TITLE: HYDROSTATIC EXTRUSION OF TITANIUM ALLOY TUBING
AUTHOR(S): G.E. Mayer, T.G. Byere, R.J. Fiorentino
CONTRACT NO: F33615-71-C-1672
CONTRACTOR: Battelle's Columbus Laboratories
PROJECT MONITOR: T. Felker (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Agencies Only
ABSTRACT: The overall purpose of this program was to apply the hydrostatic-extrusion process to the production of low-cost, thin-wall, seamless titanium-alloy tubing of a suitable quality for application in the hydraulic system of high performance aircraft. Ti-6Al-4V and Ti-3Al-2.5V tubes were produced with excellent dimensional uniformity by warm hydrostatic-extrusion techniques. A manufacturing sequence is suggested to combine a warm hydrostatic-extrusion operation with a secondary cold-finishing operation which could result in a superior product at a lower net cost than current practice.

AFML/LT

REPORT NO: AFML-TR-74-84 AD 922 823L
ACCESS NO: 203,039 May 1974
TITLE: MANUFACTURING METHODS FOR LOW COST RARE EARTH-COBALT MAGNETS
AUTHOR(S): D.L. Martin, M. Doser, C.M. McFarland, E. Richter
CONTRACT NO: F33615-72-C-1353
CONTRACTOR: General Electric
PROJECT MONITOR: H. Trinkle (AFML/LTE)
PROJECT NO: 610-2
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The project objectives were to establish and demonstrate manufacturing processes for the production of low-cost, high-performance motor magnets and to evaluate the magnets in two motors to demonstrate performance advantages. High-performance, die-pressed, Co-Sm-MM magnets have been made from low-cost powder prepared by the direct reduction of samarium-mischmetal oxides, and it has been demonstrated that use of these magnets in two different types of motors resulted in superior performance which would permit the design of a much smaller motor for the same torque rating or a 75% increase of torque for the same size. The yield making 100 lb of motor magnets was 96%, demonstrating that a satisfactory powder and magnet fabrication process had been established that could produce high-performance magnets. It can now be reasonably projected that the $30 per lb price potential can be achieved in the high volume production of a medium-size motor magnet in a highly automated plant comparable to those in existence today for production of Alnico or hard ferrites.

REPORT NO: AFML-TR-74-85 AD 921 513L
ACCESS NO: 68,209 May 1974
TITLE: FORMING TITANIUM ALLOY STRINGER SECTIONS UNDER HYDROSTATIC PRESSURE
AUTHOR(S): G.E. Meyer
CONTRACT NO: F33615-70-C-1475
CONTRACTOR: Battelle Memorial Institute
PROJECT MONITOR: J. Williamson (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The overall purpose of this program is to establish a manufacturing process and equipment to continuously produce Ti-6Al-4V alloy stringer sections having small-bend radii. In the process to be applied, flat strip is formed by dies in a hydrostatic-pressure environment as the material is continuously drawn through the pressurized fluid. A superimposed fluid pressure significantly reduces the radius around which titanium alloys can be bent, at room temperature, without cracking. The process is of interest for L-, Z-, and hat-sections used for stringers.

AFML/LT

REPORT NO: AFML-TR-74-90
ACCESS NO: 201,115 May 1974
TITLE: MANUFACTURING METHODS FOR ADVANCED COMPOSITE HONEYCOMB
AUTHOR(S): A.O. Kays, J.J. Grosko
CONTRACT NO: F33615-72-C-1278
CONTRACTOR: Lockheed-Georgia Company
PROJECT MONITOR: C. Tanis (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The Manufacturing Methods for Advanced Composite Honeycomb program constituted the first application of chopped graphite mat materials, specifically graphite paper/epoxy and aligned short staple mat (ASSM)/epoxy, to the cell walls of honeycomb structures. In Phase I, binders and fiber lengths for the graphite paper/epoxy were selected by first evaluation of laboratory paper handsheets. In Phase II, a second graphite paper machine run was made providing sufficient graphite paper, in two basic weights, for the remainder of the program. Tooling was designed and built to permit fabrication of core, by the corrugation method, for Phase IV testing. In Phase III, sufficient core was fabricated to demonstrate achievement of the manufacturing techniques and to demonstrate sequential manufacturing operations. Preliminary design data were generated in Phase IV by testing and evaluation of both flat laminates and core made from the four stock materials. Analytical methods were developed in Phase V to predict properties from the flat laminate properties for both isotropic and anisotropic materials.

REPORT NO: AFML-TR-74-104 (Volumes I-V)
ACCESS NO: 202,072 July 1974
TITLE: AIR FORCE COMPUTER-AIDED MANUFACTURING (AFCAM) MASTER PLAN
AUTHOR(S): H.E. Buffum
CONTRACT NO: F33615-73-C-5085
CONTRACTOR: Boeing Commercial Airplane Company
PROJECT MONITOR: W. Harris (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: In this ten-month project, a documented "master plan" for an Air Force Computer-Aided Manufacturing (AFCAM) program was prepared encompassing various tiers of aerospace manufacturing for future CAM planning by the Air Force and the aerospace industry. Volume I, Summary and Recommendations. Volume II, Master Plan and Glossary. Volume III, Analytical Tools. Volume IV, Catalog of Existing Modules. Volume V, Data for Module Development.

REPORT NO: AFML-TR-74-117, Vol. I
ACCESS NO: 200,375 June 1974
TITLE: MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES
AUTHOR(S): R.E. Hoffman
CONTRACT NO: F33615-72-C-1103
CONTRACTOR: RCA

PROJECT MONITOR: H. Trinkle (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this program was to provide a production capability for manufacturing the 4-½" Ultra-High Resolution Return Beam Vidicon. To this end, equipment and parts were designed and procured, processing procedures were established, and 27 tubes were built and tested to evaluate the effectiveness of the production line. Two additional tubes were built for the purpose of testing the feasibility of a cold seal to eliminate distortion of the faceplate which occurred during the standard glass-to-metal hot seal. RCA has developed the 4-½" Return Beam Vidicon (RBV) and the associated magnetic electron optics to meet the requirements of the electronic system. This report presents the testing data for all tubes fabricated during the program along with the results of experiments performed to evaluate processing procedures.

REPORT NO: AFML-TR-74-117, Vol. II
ACCESS NO: 200,375 June 1974
TITLE: MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES
AUTHOR(S): R.E. Hoffman
CONTRACT NO: F33615-72-C-1103
CONTRACTOR: RCA
PROJECT MONITOR: H. Trinkle (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this program was to provide a production capability for manufacturing the 4-½" Ultra-High Resolution Return Beam Vidicon. To this end, equipment and parts were designed and procured, processing procedures were established, and tubes were built and tested to evaluate the effectiveness of the production line. This report presents the testing data for all tubes fabricated during this program along with the results of experiments performed to evaluate processing procedures. An analysis of the faceplate-lens interface study is presented in Appendix A. This volume (Volume II) contains a complete parts list and detailed drawings of the tube, parts, subassemblies and assemblies.

REPORT NO: AFML-TR-74-123 AD 921 561L
ACCESS NO: 69,421 June 1974
TITLE: ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS
AUTHOR(S): A.J. Vazquez, A.F. Hayes
CONTRACT NO: F33615-71-C-1264
CONTRACTOR: Ladish Co.
PROJECT MONITOR: N. Klarquist (AFML/LTP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Four trials involving 21 titanium alloy forgings were conducted to isothermally forge the F-15 Titanium Stabilizer Rib forging to

precision dimensions, requiring no machining on selected difficult-to-machine surfaces. Successful solutions to tasks including die temperature uniformity, initial die precision, good surface quality, ejection of the part from the die, etc., places attainment of technical goals within reach, but not on a cost effective basis. The major obstacle to production of cost effective "net" titanium alloy forgings is the lack of a moderately priced, high-temperature die material having substantially superior creep resistance at temperatures of 1700-1800F when compared with the IN-100 die material used.

REPORT NO: AFML-TR-74-138 AD 923 548L
ACCESS NO: 69,612 August 1974
TITLE: ISOTHERMAL FORGING OF TITANIUM ALLOY BULKHEADS
AUTHOR(S): K.M. Kulkarni, T. Watmough, D. Stawarz, N.M. Parikh
CONTRACT NO: F33615-71-C-1167
CONTRACTOR: IIT Research Institute
PROJECT MONITOR: N. Klarquist, G. Trickett (AFML/LTM)
PROJECT NO: 227-1
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The goal of this program was to isothermally forge a 430 sq. in. plane area bulkhead for F-15 aircraft. The bulkhead is characterized by 23 pockets on one side, 19 pockets on the other side, ¼" web and ¼" ribs of up to 2½" in height. The part was successfully isothermally forged and represents the largest and most complex forging to be made by this technique thus far. The IN-100 forging dies were heated up to 1750F by gas heating systems. Conventionally forged blockers were used as preforms. The isothermal forgings weighed only 65 lb compared to 340 lb for the conventional forgings. This will be very significant in allowing a high rate of production. The components to be machined from isothermal forgings are cost-effective (marginally) over those machined from conventional forgings even when cost of tooling is included. The mechanical properties, microstructure, and macrostructure of the isothermal forgings were similar to or better than the conventional forgings. The isothermal forgings required a press tonnage of just above 1/4 or less in relation to tonnage for conventional forgings of much less complexity.

REPORT NO: AFML-TR-74-141 AD B000 125L
ACCESS NO: 201,731 July 1974
TITLE: PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE
AUTHOR(S): J.A. McKee
CONTRACT NO: F33615-73-C-5033
CONTRACTOR: Great Lakes Research Corporation
PROJECT MONITOR: L. Kopell (AFML/LTN)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A manufacturing process for production of carbon monofilament has been established at a pilot scale level. The potential of the carbon monofilament for use as an economic substrate for boron filament has been demonstrated.

AFML/LT

REPORT NO: AFML-TR-74-143 AD 921 824L
ACCESS NO: 202,915 August 1974
TITLE: THIN FILM GARNET MANUFACTURING METHODS
AUTHOR(S): R.G. Warren
CONTRACT NO: F33615-72-C-1299
CONTRACTOR: Rockwell International
PROJECT MONITOR: E. Tarrants (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this report is to establish a manufacturing method for the epitaxial growth of thin film bubble domain material. The initial project effort of determining the deposition method to be used for the bulk of the work (CVD vs LPE) is discussed. The methods used for growing up to ten garnet films during one deposition cycle are presented as are the techniques for obtaining reproducible film parameters within a run, between runs, and from day to day. Substrate preparation and equipment used for this work is also reported.

REPORT NO: AFML-TR-74-152 AD 922 205L
ACCESS NO: 201,117 July 1974
TITLE: PROCESS FOR HIGH-INTEGRITY CASTINGS
AUTHOR(S): P.G. Bailey, D.H. Lowe
CONTRACT NO: F33615-72-C-1381
CONTRACTOR: General Electric Company
PROJECT MONITOR: T. Felker (AFML/LTP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This program has successfully established manufacturing processes for densification of Rene´80 and Ti-6Al-4V castings, using simultaneous application of pressure and temperature in a gas autoclave. The processes demonstrated in this program provide economical methods of producing fully dense components with more uniform mechanical properties and lower scrap losses. The program dramatically demonstrated that shrinkage porosity is closed and metallurgically bonded in the densification process, resulting in enhancement of mechanical properties, especially fatigue strength. Zones of a casting that are already dense and homogeneous are affected little by the densification process. The manufacturing processes for Rene´80 and Ti-6Al-4V were established on cast slabs and demonstrated on production hardware. Processes established include surface bridging techniques for encapsulating surface connected porosity, densification parameters of temperature, pressure and time, and choice of effective NDT techniques for process control.

REPORT NO: AFML-TR-74-154
ACCESS NO: 201,116 August 1974
TITLE: HIGH STRENGTH TURBINE BLADE DOVETAILS
AUTHOR(S): R.G. Rajala
CONTRACT NO: F33615-72-C-1276
CONTRACTOR: General Electric Company

PROJECT MONITOR: F. Miller (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A program to establish a manufacturing process to provide a multicomponent turbine blade with increased dovetail strength is described in this report. An inertia welded, high strength dovetail turbine blade provides either significant improvements in turbine blade dovetail life or weight reductions in turbine rotor design. The design analysis, fabrication procedures, test results, and cost analysis for manufacturing an inertia welded Rene'120 superalloy airfoil/Rene' 95 superalloy dovetail high pressure turbine blade are described. The effort, although primarily directed toward the F101 high pressure turbine blade, was sufficiently complete to demonstrate that the process can be readily adapted to other advanced air-cooled turbine blades.

REPORT NO: AFML-TR-74-158, AFFDL-TR-74-105
ACCESS NO: 201,114 August 1974
TITLE: ADHESIVELY BONDED MULTI-LAYER F-104 FUSELAGE RING FITTING
AUTHOR(S): J.R. Ellis, G.E. Kuhn
CONTRACT NO: F33615-72-C-1618
CONTRACTOR: LTV Aerospace Corporation
PROJECT MONITOR: E. Wheeler (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The purpose of this program was to develop structural concepts and establish manufacturing techniques for using adhesively bonded multi-layer metallic sheet construction in complex aircraft structural components. The component selected as the vehicle for this effort was the F-104 AFT Fuselage Ring Fitting. This component was redesigned using adhesively bonded laminated titanium (Ti-6Al-6V-2Sn) sheet material. For approximately the same weight, the laminated Ti-6-6-2 component exhibited twice the fatigue life of its titanium forging counterpart, and displayed greatly improved damage tolerance. Cost studies showed the laminated part to be 24% less expensive than the titanium forging based on a production run of 200 A/C. When the laminated Ti-6-6-2 component was compared to the original F-104 part, a 4340 steel forging, a 37% weight reduction resulted, with equal life and equal fabrication cost.

REPORT NO: AFML-TR-74-168 AD 922 979L
ACCESS NO: 203,047 August 1974
TITLE: MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES
AUTHOR(S): F.A. Halden, W.J. Silva
CONTRACT NO: F33615-72-C-1273
CONTRACTOR: Crystal Technology
PROJECT MONITOR: E. Tarrants (AFML/LTE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Production-scale unit operations were developed for the manufacture of gadolinium gallium garnet substrate wafers at a rate of

greater than 1000 wafers per month. At the completion of this program <111> wafers were being produced for sale in three standard diameters -- 1 inch, 1½ inches, and 2 inches. Material being produced meets all conventional requirements in terms of lattice constant (composition), inclusion concentration, dislocation concentration, and internal strain. Evaluation of magnetic garnet film depositions have confirmed the quality of substrates produced and the ability of in-process quality assurance procedures to detect substandard products. The major need for additional developmental effort is in improving the reliability of polishing defect-free substrate surfaces on a large-scale production basis.

REPORT NO: AFML-TR-74-184 AD 922 864L
ACCESS NO: 200,990 September 1974
TITLE: FABRICATION PROCESS FOR ALUMINUM COMPOSITES
AUTHOR(S): G.B. Bilow, J.T. Tesson
CONTRACT NO: F33615-72-C-1295
CONTRACTOR: McDonnell Aircraft Co.
PROJECT MONITOR: C. Anderson (AFML/LTN)
PROJECT NO: 852-2
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Low pressure autoclave (less than 300 psi) master alloy bonding, braze bonding, and eutectic bonding of Borsic/aluminum were evaluated. The master alloy bonding system was selected as providing the best combination of properties, cost, and fabricability. Borsic/6061 master alloy manufacturing processes were established for fabrication of ten-foot long tee stringers and complex wing skin panels. The wing panel design incorporated features such as titanium interleaves for bearing reinforcement and build-ups around attachment and access hole areas. Extensive NDT examination, mechanical property characterization, and producibility/cost analyses were performed. Simple low cost tooling techniques were established as being applicable to a low pressure borsic/aluminum production operation. Production capability and reliability were demonstrated by the successful fabrication of thirteen 10-ft. tee stringers and three complex wing skin panels.

REPORT NO: AFML-TR-74-202 AD B001 110L
ACCESS NO: 203,286 October 1974
TITLE: PHASE SHIFTER MANUFACTURING METHODS
AUTHOR(S): R.E. May, D.J. Lewis
CONTRACT NO: F33615-73-C-5160
CONTRACTOR: Hughes Aircraft Company
PROJECT MONITOR: H. Trinkle (AFML/LTE)
DIST. STATEMENT: U.S. Govt. 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-74-204 AD 923 610L
ACCESS NO: 203,083 October 1974
TITLE: ISOTHERMAL SHAPE ROLLING OF TITANIUM AND SUPERALLOYS
AUTHOR(S): W.J. Carpenter, F.K. Rose, A.G. Metcalfe
CONTRACT NO: F33615-72-C-1217
CONTRACTOR: International Harvester
PROJECT MONITOR: L. Clark, J. Hager (AFML/LTM)
PROJECT NO: 103-2
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A new manufacturing method for straight structural sections with net dimensions has been demonstrated by production of short lengths of channels in Inconel 718, Z-sections in Ti-6Al-4V, T-sections in Ti-6Al-4V and Hastelloy X, and by I-sections in Ti alloys. The method is based on in-situ heating by passing electric current between the rolls. This demonstration was followed by establishment of a continuous rolling method to make 1.5 x 1.25 x 0.050 in. Ti-6Al-4V T-sections in a single roll pass from feed stock machined from 1.5 x 0.250 in. strip stock, or by two roll passes from rectangular 0.75 x 0.250 in. strip stock.

REPORT NO: AFML-TR-74-219 AD B000 533L
ACCESS NO: 203,235 December 1974
TITLE: RENE' 95 (AF-95) SHEAR SPIN FORMING TECHNIQUES
AUTHOR(S): R.M. Cogan, C. Shamblen
CONTRACT NO: F33615-72-C-1714
CONTRACTOR: General Electric
PROJECT MONITOR: J. Williamson (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A program to reduce manufacturing cost of conical shape jet engine components by the adaption of the shear spin forming process of Rene' 95 (AF 95) is described. Heat treatment studies were conducted which identified the optimum softening treatment (2000F/24 hr, 1800F/24 hr./O.Q.) for optimum formability and evaluated final properties of shear spin formed and heat treated Rene' 95 (AF 95). Shear spin forming parameters were established for Rene' 95 (AF 95) having a minimum tensile reduction of area of 26%. The processing sequence of two shear spin forming reductions of 25% each was successfully demonstrated on a sub-scale F101 compressor rear shaft for the B-1 bomber. Erratic machine deflections in the shear spin forming operations and inferior ductility of the materials procured for the full scale parts were the major problem areas experienced in the program.

REPORT NO: AFML-TR-74-227
ACCESS NO: 200,033 January 1975
TITLE: MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS
AUTHOR(S): J.A. Petrusha
CONTRACT NO: F33615-71-C-1573
CONTRACTOR: Garrett Corporation
PROJECT MONITOR: R. Kennard, K. Love (AFML/LTM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The difficulty and cost encountered in forging and machining integral turbine wheels from AF2-1DA alloy make investment casting attractive for manufacturing methods for casting an integral radial-flow turbine wheel from AF2-1DA alloy. Initial work indicated that the AF2-1DA composition developed for wrought applications was not suitable for casting integral turbine wheels; however, this deficiency was corrected by appropriate chemical composition modification. The casting parameters and heat treatment techniques for manufacturing high-quality wheel castings from the modified alloy were established. Reproducibility and reliability of this manufacturing process were demonstrated under pilot production conditions. Complete mechanical property and metallurgical evaluations of the modified AF2-1DA turbine wheel castings were conducted including a 50-hour engine test.

REPORT NO: AFML-TR-74-237
ACCESS NO: 201,738 November 1974
TITLE: MANUFACTURING METHODS FOR PRODUCTION OF QUALITY SUPERALLOY ENGINE PARTS
AUTHOR(S): J.D. Jackson, T.S. Piwonka
CONTRACT NO: F33615-72-C-1967
CONTRACTOR: TRW Inc.
PROJECT MONITOR: R. Kennard, T. Felker (AFML/LTM), R. McMichael (ASD/PPDM)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A concept of mechanization was applied to several production steps for precision investment castings. Integral injection of pattern and sprue, and a dual injection of the sprue around the patterns, rapid mold preparation, electrostatically assisted mold drying, continuous microwave dewaxing, vacuum-formed reusable insulating cans, a vacuum rollover furnace, and a bulk melt and mini-pour crucible pouring concept were investigated in a two-year program. With the exception of electrostatic drying, these concepts were found to be technically feasible and economically advantageous when compared with current production methods. This study indicates that production costs through pouring can be reduced by up to 77% for solid blade castings when using these concepts with the mini-pour furnace. Capital expenditures for a mechanized plant were estimated at $4.1 million. Equipment and procedures were specified.

NON-METALLIC MATERIALS DIVISION (AFML/MB)

REPORT NO: AFML-TR-73-119 AD 919 400L
ACCESS NO: 202,627 November 1973
TITLE: SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS
AUTHOR(S): L.W. Breed, J.C. Wiley
CONTRACT NO: F33615-72-C-1627
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: H. Rosenberg (AFML/MBP)
PROJECT NO: 7342
TASK NO: 734201
DIST. STATEMENT: U.S. Govt Only
ABSTRACT: Methods of synthesis were developed for monomers useful in the preparation of phenyl-substituted, silicon-modified heterocyclic polymers. Satisfactory procedures are outlined for diphenyl 4,4'-(1,1,3,3,-tetraphenyldisiloxanylene) dibenzoate and for 4,4'-(1,1,3,3,-tetraphenyldisiloxanylene) dibenzonitrile, which are benzimidazole and benzoxazole precursors. 4,4'-(1,1,3,3-tetraphenyldisiloxanylene) dianiline was also prepared but in a low yield. The monomers have been converted into the model compounds, 1,3-bis(2-p-benzoxazoylphenyl)-1,1,3,3-tetraphenydisiloxane, 1,3-bis(2-p-benzimidazoylphenyl)-1,1,3,3-tetraphenyldisiloxane, and 1,3-bis(p-phthalimidophenyl)-1,1,3,3-tetraphenyldisiloxane, and the properties of these compounds are described.

REPORT NO: AFML-TR-73-119, Part II AD B000 589L
ACCESS NO: 203,209 June 1974
TITLE: SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS
AUTHOR(S): L.W. Breed, J.C. Wiley
CONTRACT NO: F33615-72-C-1627
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: H. Rosenberg (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Methods of synthesis were developed for phenyl-substituted, siloxane-modified polybenzimidazoles and polybenzoxazoles. The polymers were characterized, their solubilities in various solvents determined, and thermooxidative 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-73-136 AD 916 696L
ACCESS NO: 79,616 August 1973
TITLE: EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS
AUTHOR(S): G.F. Schmitt, R.C. Hall
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: G. Schmitt (AFML/MBE)

DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Rotating arm erosion experiments coupled with spectrophotometric measurements of laser transmittance through polycarbonate and polysulfone transparent plastic materials before and after subsonic rain exposure are described. Significant decreases of up to 80% in transmittance at 1.06 microns through polycarbonate and polysulfone transparent plastics are measured after short-term subsonic rain erosion exposure. The major changes in transmittance of these plastics occur during the incubation period of erosion. Although both plastics lack long-term subsonic rain erosion resistance, polycarbonate is superior to polysulfone in retention of transmittance after exposure. Greater impact strength and ductility of the bulk plastic improves its erosion resistance and reduces subsequent loss in transmittance properties.

REPORT NO: AFML-TR-73-205 AD 919 397L
ACCESS NO: 300,297 August 1973
TITLE: DEVELOPMENT OF THERMALLY STABLE DYED FABRIC
AUTHOR(S): N.J. Abbott, J.S. Ranto
CONTRACT NO: F33615-73-C-5134
CONTRACTOR: Fabric Research Labs, Inc.
PROJECT MONITOR: S. Schulman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this work was to manufacture 500 flight suits of thermally stabilized, dyed, wash resistant PBI fabric weighing 4.5 oz/yd$^2$. One thousand eighty four pounds of 2-inch, 1.5 dpf PBI fiber was acid treated, heat stabilized, and dyed by techniques developed by FRL under other Air Force contracts. This was spun into 37/2 yarn and woven into a 4.5 oz., 2/1 twill fabric by Textile Research Services, Inc., using a fabric construction developed for the purpose by FRL. Five hundred flight suits in assorted sizes were manufactured from this fabric by Worklon, Inc.

REPORT NO: AFML-TR-73-216 AD 919 102L
ACCESS NO: 202,673 December 1973
TITLE: PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I
AUTHOR(S): C.B. Delano, E.S. Harrison
CONTRACT NO: F33615-72-C-1755
CONTRACTOR: Whittaker Corporation
PROJECT MONITOR: C. Browning (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734003
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The room temperature aging of graphite reinforced epoxy composites is known to reduce their high-temperature strength

properties. This strength loss is primarily due to the plasticization of the resin by water. Cyanate resins were investigated for their ability to perform better than epoxy resins in this application. Several modifications were made to the resin system and a five-fold reduction in equilibrium moisture content was achieved (5% to 1%). This achievement, however, did not lead to better retention of the high-temperature properties of the composites.

REPORT NO: AFML-TR-73-216 AD 921 155L
ACCESS NO: 202,837 April 1974
TITLE: PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II
AUTHOR(S): C.B. Delano, E.S. Harrison
CONTRACT NO: F33615-72-C-1755
CONTRACTOR: Whittaker Corporation
PROJECT MONITOR: C. Browning (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734003
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Incorporation of 10 mole percent 4,4'-dicyanatobiphenyl into the AF-R-10 resin system derived from resorcinol dicyanate resulted in an approximate 50% reduction in water pickup in humid environments. Outstanding initial thermomechanical response of Modmor II graphite fiber laminates was developed wherein essentially theoretical flexural strengths and moduli were maintained throughout the temperature range of room temperature to 365F. Laminate response after humid aging showed complete retention of room temperature properties but a fall-off at 365F. Very high shear strength adhesive bonds which had good resistance to water boil resulted from the same system. Alternate dicyanate resins, notably isopropylidine-4,4'-bis(2,6-dimethylcyanatobenzene), show very low moisture pickup values both in powdered resin and laminate form. Laminate properties and adhesive bonds suffered in comparison to AF-R-10 based systems, but promising results were obtained in both humid aging response (laminates) and water boil studies (adhesive bonds).

REPORT NO: AFML-TR-73-221
ACCESS NO: 202,432 November 1973
TITLE: HETEROCYCLIC POLYMERS DERIVED FROM 1,2,4,5-NAPHTHALENETETRACARBOXYLIC ACID DIANHYDRIDE
AUTHOR(S): G.A. Loughran, F.E. Arnold
CONTRACT: internal
CONTRACTOR: N/A
PROJECT MONITOR: F. Arnold (AFML/MBP)
PROJECT NO: 7340
TASK NO: 734004

DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Polycondensation of 3,'-diminobenzidine and 1,2,4,5-naphthalenetetracarboxylic acid dianhydride in aprotic solvents at 80C to 120C gave soluble low molecular weight polymers. Increasing the reaction temperature to 160C led to further condensation and gave increasing amounts of undesirable insoluble cross-linked material. Some higher molecular weight soluble polymer was used when m-cresol was used as a solvent. The low molecular weight polymers could be further condensed and chain extended with about a twofold increase in molecular weight by heating at 250C/0.1 mm. However, linear polymers which had been prepared in aprotic solvents up to 80C on "second-staging" gave 33% to 39% of soluble cross-linked material. This is believed to be due to a branching reaction taking place between 80C and 120C at the ortho anhydride linkage.

REPORT NO: AFML-TR-73-237 AD 916 594L
ACCESS NO: 79,611 November 1973
TITLE: HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUORELASTOMER COATINGS
AUTHOR(S): R.L. Visger
CONTRACT NO: F33615-71-C-1468
CONTRACTOR: Olin Corporation
PROJECT MONITOR: G. Schmitt (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Development of high temperature resistant, erosion resistant fluoroelastomer coatings has been continued. A coating system with excellent adhesion to fiberglass/epoxy laminates was developed. The priming system utilizes a low molecular weight fluorocarbon resin in conjunction with a tetrathiol curing agent. Adhesion to glass laminate substrates was confirmed by static 180C peel strengths and dynamic rain erosion testing. A solvent system was developed which allows for rapid coating thickness build-up. White fluoroelastomer coating development was initiated. Process studies, film performance, and property relationships before and after accelerated conditioning are described. Chemical resistance of the cured fluoroelastomer coating was measured and found to be excellent.

REPORT NO: AFML-TR-73-242 AD A004 843
ACCESS NO: 202,572 December 1973
TITLE: RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR
AUTHOR(S): R.D. Stockwell, J.W. Kissell, D.B. Hamilton
CONTRACT NO: F33615-73-C-5087
CONTRACTOR: Battelle
PROJECT MONITOR: R. Benzing (AFML/MBT)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Three experimental apparatuses have been designed, constructed, and delivered to AFML. These apparatuses will be used to develop

experimental data which can be used to devise accelerated life tests for bearings and slip rings for mechanically despun antenna drive systems for AF communications satellites. Two apparatuses were designed for the purposes of studying lubricant degradation and dewetting in ball bearings operating in vacuum. The third apparatus was designed to evaluate lift tests for slip rings operating in vacuum. The report appendices contain operating instructions for the various apparatuses.

REPORT NO: AFML-TR-73-243 AD 918 864L
ACCESS NO: 202,596 February 1974
TITLE: EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I
AUTHOR(S): R.W. Vaughan, R.J. Jones, T.V. Roszhart
CONTRACT NO: F33615-72-C-2122
CONTRACTOR: TRW Systems
PROJECT MONITOR: C. Browning (AFML/MBC)
PROJECT NO: 7340
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A new polyimide resin was developed that provides processing characteristics and basic mechanical properties equivalent to those of commercially available high performance epoxy resins. This new resin, DONA polyimide resin, provides high resistance to moisture, thus overcoming a major problem associated with the high performance epoxy resins. An alternative polyimide resin, DAS polyimide resin, also was identified but was not developed to the same level as the DONA resin. Fracture toughness studies were performed on DONA/A-S graphite fiber composites and comparisons were drawn with epoxy/A-S graphite fiber composites. Strength retention at 365F of these composites was equivalent to that of high performance epoxy systems.

REPORT NO: AFML-TR-73-243, Volume II. AD B000 374L
ACCESS NO: 202,596 July 1974
TITLE: EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY.
AUTHOR(S): R.W. Vaughan, R.J. Jones, T.V. Roszhart
CONTRACT NO: F33615-72-C-2122
CONTRACTOR: TRW Systems
PROJECT MONITOR: L. Picklesimer (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Further studies were performed with the hydrolytically stable DONA polyimide resin developed under Phase I of this program. Objectives of the Phase II and III studies were to identify a DONA resin formulation that does not contain TDA, to identify a lower boiling solvent system than DMF or NMP, to identify an alternative low temperature curing end-cap to DONA, and to evaluate DONA and DAS resins as adhesives. It was

demonstrated that TDA is not an essential constituent of the autoclave moldable DONA polyimide resins containing BSDA. However, attempts to identify a lower boiling solvent or an alternative end-cap to DONA were unsuccessful. Adhesive bonding studies demonstrated high promise for the DONA resin system as a structural adhesive. These studies indicated low promise for the DAS resins as structural adhesives.

REPORT NO: AFML-TR-73-245 AD 779 717
ACCESS NO: 202,650 January 1974
TITLE: ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM
AUTHOR(S): N.T. McDevitt
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: N. McDevitt (AFML/MBM)
PROJECT NO: 7340
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The results of ellipsometric measurements on 2024-T-3 clad aluminum surfaces subjected to various etching treatments are presented. Measurements on the "bare" aluminum substrate indicate the complex refractive index is 1.14 (1-i4.06). Oxide film growth on the substrate shows the ellipsometric parameter delta decreases linearly as the film grows to 300 angstroms. It is observed that the variation of the ellipsometric parameter psi with small changes in the absorption coefficient of the film is much larger than the variation in delta. The general results of this study reveal that in most cases an average oxide film thickness can be determined, but surface inhomogeneity due to the etching solution can lead to incorrect interpretation of oxide film thickness if ground rules for matching observed to calculated data are not established.

REPORT NO: AFML-TR-73-256 AD 918 901L
ACCESS NO: 300,132 February 1974
TITLE: SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS
AUTHOR(S): A.J. Sicree, F.E. Arnold
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: F. Arnold (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A new aromatic heterocyclic tetraamine 2,3,7,8-tetraminodibenzothiophene-5,5-dioxide has been prepared. This monomer is tailored in structure for conversion to specific geometric isomers in an imidazoisoquinoline ladder polymer system. Polymerization of the new tetraamine was accomplished with both 1,4,5,8-naphthalenetetracarboxcyclic acid and the parent acid dianhydride. The resulting formation of a high molecular weight ladder polymer is the first step to obtaining a highly ordered high temperature polymer. This polymer exhibits excellent thermal

stabilities resisting degradation up to temperatures near 550C under nitrogen and near 510C in air by thermogravimetric analysis, thus increasing the potential for obtaining useful mechanical behavior at higher temperatures than current state-of-the-art nonmetallic materials.

REPORT NO: AFML-TR-73-257
ACCESS NO: 200,984 January 1974
TITLE: SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION
AUTHOR(S): R.J. Lagow, J.L. Adcock, B.D. Catsikis, J.W. Thompson
CONTRACT NO: F33615-72-C-1536
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: C. Tamborski (AFML/MBP)
PROJECT NO: 7340
TASK NO: 734004
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Direct fluorination techniques for the preparation of difunctional monomers,preferably those containing ether linkages in the monomer backbone, have been extensively investigated. It has been found that carbon-oxygen linkages resist cleavage by elemental fluorine to an extent comparable to that found for carbon-carbon linkages. Functional groups investigated included the acid anhydrides, acyl chlorides, nitriles, and cyclic amines. The fluorination products, perfluoroacid anhydrides, perfluoroacyl fluorides,and perfluoro-N-fluoroamines are envisioned as precursors to the perfluorodicarboxylic acids. Initial results for other ethers indicate that the advanced direct fluorination techniques employed are significant improvement over electrochemical fluorination techniques with respect to yields, and for the functional groups described are similar to those found in electrochemical fluorinations.

REPORT NO: AFML-TR-73-270 AD 918 564L
ACCESS NO: 202,461 January 1974
TITLE: IMPROVED SURFACE TREATMENTS OF TITANIUM ALLOYS FOR ADHESIVE BONDING
AUTHOR(S): G.W. Lively
CONTRACT NO: F33615-72-C-1588
CONTRACTOR: LTV Aerospace Corporation
PROJECT MONITOR: E. Arvay (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report describes the further development of an improved surface treatment for titanium alloys for adhesive bonding the chemical analysis of the prepared surfaces. The treatment called VAST (Vought Abrasive Surface Treatment) was found to be an effective surface treatment for titanium sheet material and with titanium honeycomb for

sandwich constructions as measured by the strength and durability of bonded joints. This new process, which is a combination grit impact/chemical etch treatment conducted in a specially fabricated chamber, is described and compared to bonded joint results prepared with conventional treatments. The compatibility of combinations of titanium alloys modified epoxy, epoxy novalac and polyimide adhesives, various surface treatments under various environmental exposure conditions were investigated in stressed and unstressed conditions.

REPORT NO: AFML-TR-73-275
ACCESS NO: 203,347 August 1974
TITLE: IMPROVED ATJS GRAPHITE: PART I. MATERIALS AND PROCESS STUDIES
AUTHOR(S): J.M. Criscione, J.C. Fisher, R.E. Booth
CONTRACT NO: F33615-72-C-1939
CONTRACTOR: Union Carbide Corporation
PROJECT MONITOR: J. Latva (AFML/MBC)
DIST. STATEMENT: U.S. Govt. 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% increase in tensile strength and a 24% increase in strain-to-failure over that of production Grade ATJS graphite.

REPORT NO: AFML-TR-73-303 AD 917 398L
ACCESS NO: 202,506 January 1974
TITLE: EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE TRIAZINE ELASTOMERS
AUTHOR(S): Y.K. Kim, G.R. Cappo, A.M. Alanko
CONTRACT NO: F33615-72-C-1622
CONTRACTOR: Dow Corning Corporation
PROJECT MONITOR: W. Griffin (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objective of this research program was to solve the problem of hydrolysis of the s-triazine ring in the perfluoroalkylene s-triazine polymer system by reducing the negative inductive effects and increasing steric blocking of the substituent perfluoroalkyl group with branching on the carbon alpha to the ring. The initial and crucial phase of this program was the synthesis of alpha, omega-sec-perfluoroetherdicarboxylic acid intermediates required for the monomer preparation. Ethylene addition and dehydrohalogenation reactions readily converted the alpha, omega-sec-dihaloperfluoroethers to alpha, omega-sec-divinylperfluoroether. These compounds were found to be resistant to $KMnO_4$ oxidation to yield the corresponding alpha, omega-sec-dicarboxylic acids.

REPORT NO: AFML-TR-73-311
ACCESS NO: 202,571 January 1974
TITLE: A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS
AUTHOR(S): G.C. Grimes, P.H. Francis, G.E. Commerford, G.K. Wolfe
CONTRACT NO: F33615-71-C-1574
CONTRACTOR: Southwest Research Institute
PROJECT MONITOR: J. Whitney (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The purpose of this investigation was to attempt to obtain by experimental means a rigorous definition of the stress level within a composite specimen at which physical damage and/or degradation of mechanical properties was initiated. The goal of the study was to show that the composite material resistance to subsequent loadings is seriously impaired. This purpose and goal are similar to the ones pursued on a cursory basis in Reference 1. In continuing the study on the HTS/ERL 2256 graphite epoxy, the axially loaded flat specimen, tube test and characterization program was continued. In this program, load-introduction problems on tubes were studied along with compression test methods. Additional fatigue data were generated, showing good correlation with significant damage stress levels. Maximum strain criterion was used to predict the proportional limit and ultimate strength with considerable success. A large number of tubes were fabricated for testing in the balance of the program.

REPORT NO: AFML-TR-73-312 AD 919 164L
ACCESS NO: 202,652 February 1974
TITLE: PREPARATION OF SOME POLYOXAZOLIDONES AND EVALUATION OF THEIR MOISTURE RESISTANCE
AUTHOR(S): W.S. Port, R.C. Loszewski
CONTRACT NO: F33615-73-C-5145
CONTRACTOR: AVCO
PROJECT MONITOR: C. Browning (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734003
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A program was conducted comprising the preparation and evaluation of oxazolidone polymers. Conditions for polyoxazolidone preparation were established from model reaction studies using mono-epoxides and, respectively, a bis-amine-imide and a bis-carbamate. The polymer evaluation studies comprised determining the weight and dimensional changes of specimens aged at 160F and 95% relative humidity for seven days and the effect of such exposure on the coefficient of linear thermal expansion, on the glass transition temperature and on selected mechanical properties. Weight increases were low and dimensional changes were negligible. There were

small or no changes in the coefficient of linear expansion and in the glass transition temperature. Tensile strength could not be used as a parameter for determining the effect of the exposure on mechanical properties because of poor reproducibility of the results. However, modulus of elasticity changes were consistent and low (for the most part) and correlated with the extent of moisture absorption.

REPORT NO: AFML-TR-73-313 AD 787 744
ACCESS NO: 202,772 January 1974
TITLE: GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES
AUTHOR(S): T.B. Belytschko, J. Burke, A.B. Schultz
CONTRACT NO: F33615-73-C-5148
CONTRACTOR: University of Illinois
PROJECT MONITOR: S. Tsai (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This graphics package was developed for the purpose of illustrating three dimensional mechanics problems of importance to the researcher in composite structures and fan blade mechanics. The package has been specifically developed to illustrate failure surfaces in stress or strain space, and deformed fan blades under bird impact with both bending and twisting of cross-sections. These geometrical figures can be viewed from any point and hidden portions of the figures are deleted. Some sample results for both problems are given.

REPORT NO: AFML-TR-74-9 AD 920 989L
ACCESS NO: 202,990 May 1974
TITLE: HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT
AUTHOR(S): T.L. Graham
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: M. Minges (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734005
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This development effort was conducted for the purpose of attaining a thermally stable (400F minimum) rain erosion resistant elastomeric boot material for the protection of radomes and other leading edges of advanced aircraft from damage by impacting rain droplets at subsonic flight speeds. It also involved attaining a suitable high temperature adhesive. Compounding efforts resulted in the development of a 500F stable fibrous reinforced fluoroelastomer based boot material which exhibits excellent resistance to rain erosion. A low temperature (200F) curing, 400F resistance epoxy resin adhesive system was found which proved to be effective for bonding. The radar transparency of this type boot material appears to be adequate but it is not electrically conductive for antistatic protection.

AFML/MB

REPORT NO: AFML-TR-74-11 AD 784 787
ACCESS NO: 202,906 May 1974
TITLE: INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL CHARACTERIZATION
AUTHOR(S): E. Jantzen, G. Spengler
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: G. Morris (AFML/MBT)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Test methods, apparatus, and procedures are described for use up to 800F, a 20 milliliter amount of sample oil and a test time of 24 hours. The influence of various important parameters on oxidation-corrosion are presented. The reduction of the test duration to 24 hours was optimized. Oxidation/corrosion studies at several different temperatures and the resulting oil deterioration curves were shown to be meaningful from a minimum of 392F to a maximum of 700F. The selection of the proper air flow was coupled with the reduced sample size as most appropriate for this work. The selection of high purity metal catalysts was justified. Analysis methods used in this work and their relative merits are discussed. Finally oxidation-corrosion data is presented on a few typical base stocks using this method.

REPORT NO: AFML-TR-74-12
ACCESS NO: 202,649 March 1974
TITLE: DIELECTROMETER MONITORED ADHESIVE BONDING
AUTHOR(S): E.A. Arvay, P.W. Centers
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: E. Arvay (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An automatic dielectrometer was investigated as a means for monitoring the cure of a structural adhesive during an in-press bonding operation. The instrument was found to be sensitive to changes occurring within the adhesive, as indicated by relative values of the dielectric constant and the dissipation factor, during the bonding of metallic adherends. Insulation and shielding techniques were developed to obtain relatively noise-free dielectrometer traces while operating in the electrically noisy environment of a heated platen, hydraulic press. Definitive curves were obtained on both an epoxy type and a polyimide type adhesive system under a constantly increasing temperature cure cycle. These traces were used to design an experiment to determine the effect upon resultant joint strength of varying the point at which full bonding pressure was applied to polyimide adhesive bonded tensile lap shear joints.

AFML/MB

REPORT NO: AFML-TR-74-13 AD 783 841
ACCESS NO: 202,886 May 1974
TITLE: AN ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE
AUTHOR(S): H.T. Hahn, S.W. Tsai
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: S. Tsai (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Failure surface of laminated composites can be constructed in special strain space such that the transformation of strain components becomes an orthogonal matrix. This construction provides a convenient means of studying strength of laminates consisting of arbitrary lamina orientations. This special construction of failure surface can be based on the maximum strain theory, the tensor polynomial theory or other failure criteria of the lamina. The effect of nonlinearity due to shear on the failure surface is also illustrated.

REPORT NO: AFML-TR-74-16 AD 783 617
ACCESS NO: 202,874 April 1974
TITLE: CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER
AUTHOR(S): D.R. Wiff, M.T. Gehatia
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: M. Gehatia (AFML/MBP)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An automatic "hands-off" magnetic float pycnometer developed in this laboratory was applied in preliminary research to determine the partial specific volume of polymer in solution. During this phase of the research it became obvious that the original calibration was not adequate. To improve this technique a few modifications have been made, by adding a new digital ammeter and by replacing part of the homemade electronics with a commercial phase lock-in amplifier. Then a new comprehensive calibration was performed and all parameters required to characterize the apparatus and the float were determined. Finally, partial specific volume of the polymer polystyrene in cyclohexane was investigated by applying the new magnetic float pycnometry and also by using the conventional technique. The results obtained from both methods were in excellent agreement. The instrument will significantly shorten experimental time and result in cost reduction.

REPORT NO: AFML-TR-74-22 AD 918 253L
ACCESS NO: 202,573 February 1974
TITLE: HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS
AUTHOR(S): C.B. Delano, R.R. Doyle, R.J. Milligan
CONTRACT NO: F33615-72-C-1458
CONTRACTOR: Whittaker Corporation

PROJECT MONITOR: W. Gloor (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The subject program has been concerned with the synthesis of specifically ordered heterocyclic polymer systems for evaluation as high tenacity fiber candidates. Specifically sought in the performance spectrum of successful fibers was a high level of mechanical properties, high energy absorption ,and high temperature performance. The primary structural criteria for polymer order were: chain growth which describes a straight line; the absence of bulky pendant groups; capability for approaching a planary structure and interchain bonding. Efforts with the poly-2,5(6)-benzimidazole did not produce a yarn whose properties exceeded the previous contract yarn strengths of: as spun T/E/Mi = 7.4 gpd/3%/97 gpd; drawn TOE/Mi = 13.2/2.2/501. It is thought that low solids content dopes used in yarn formation present peculiar difficulty in the attainment of a higher strength yarn. Achievement of higher solids concentration in the dopes for yarn formation should provide enhanced yarn properties from AF-R-56.

REPORT NO: AFML-TR-74-25 AD 922 438L
ACCESS NO: 202,946 April 1974
TITLE: FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION
AUTHOR(S): G.F. Schmitt, Jr.
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: G. Schmitt (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A white thermal flash resistant, high temperature resistant, and subsonic rain erosion resistant coating based upon fluorocarbon elastomers has been developed which represents significant advantage in the state-of-the-art. The coatings provide average rain erosion resistance of 65 minutes to failure at 500 mph in 1 inch/hour simulated rainfall and retains 80% of this resistance after 200 hours at 400F and 100% of this resistance after 6 months of Florida weathering. Because of the combination of properties above, this coating is a strong candidate for aircraft systems where thermal flash protection of the radome is essential while also providing subsonic rain erosion resistance, radar transmission and high temperature resistance.

REPORT NO: AFML-TR-74-32 AD 779 672
ACCESS NO: 202,694 February 1974
TITLE: INELASTIC ELECTRON SPECTROSCOPY STUDY
AUTHOR(S): T.P. Graham, R.G. Keil
CONTRACT NO: F33615-73-C-5149
CONTRACTOR: University of Dayton Research Institute

PROJECT MONITOR: W. Baun (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Activities regarding the design, construction and testing of equipment necessary for sample preparation and the inelastic electron tunneling spectrometer are described in detail. To successfully prepare a tunnel junction the supplied vacuum had to be made functional and then modified so that the following functions could be performed: (1) metal evaporation, (2) metal oxidation by glow discharge,and (3) oxide contamination through bleed-in devices. Many of the difficulties encountered and the procedures used to eliminate them are discussed. Experimental tunnel junction spectral data are included and discussed in view of existing literature.

REPORT NO: AFML-TR-74-43 AD 921 484
ACCESS NO: 202,868 April 1974
TITLE: SAPPHIRE FILAMENTS
AUTHOR(S): C.R. Mitchell, G.F. Hurley
CONTRACT NO: F33615-73-C-5065
CONTRACTOR: Tyco Laboratories, Inc.
PROJECT MONITOR: W. Gloor (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Using the Tyco developed EFG crystal growing technique, continuous lengths of ruby, $Al_2O_3$-$Cr_2O_3$-$TiO_2$, $Al_2O_3$-$Fe_2O_3$, and $Al_2O_3$-$CaF_2$ filament were grown and characterized at temperatures up to 1300C. Results exhibited average tensile strengths of 135 ksi, for systems containing 0.5 wt% Cr in $Al_2O_3$, compared to 105 ksi for $Al_2O_3$ both at 1310C. In addition, the room temperature strength of ruby filament was improved to over 400 ksi, a figure comparable to the room temperature strength of sapphire. An investigation into the feasibility of growing thin (approx. 0.005 in.) ribbons was also conducted. Several thin ribbons (0.006 x 0.230 in.) between 6 and 11 inches long were characterized by bend testing and exhibited as-grown strengths of 190 ksi.

REPORT NO: AFML-TR-74-45
ACCESS NO: 203,073 September 1974
TITLE: EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES
AUTHOR(S): R.W. Farmer
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: R. Farmer (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734001
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An analysis was made of experimental and analytical investigations of the ablation of carbon phenolic and silica phenolic composites under exterded heating conditions. Specimens of up to 8.75 sq.in.

in area and instrumented with indepth thermocouples were characterized under stepwise pulses of either five minutes or up to 1.4 minutes in duration using two air arc heaters. The nominal peak heat load was 35,000 Btu/sq. ft. Internal and surface temperatures, recession rates, and recession patterns in the residual char were not anomalous for the two step, low shear (to 2.5 lb/sq. ft.) runs. Charring-ablator theory in-depth and surface temperature responses agreed well with experimental results for a carbon phenolic. For the five-step condition with a moderate peak shear (30 lb/sq. ft.) there was cinefilm evidence of micromechanical surface removal at late times. Micromechanical effects, by difference, were further consistent with theory. Reliable composite properties were found to be necessary to accurately model extended heating ablation.

REPORT NO: AFML-TR-74-58 AD 922 177L
ACCESS NO: 202,934 March 1974
TITLE: DEVELOPMENT OF ULTRAVIOLET LIGHT STABILIZATION METHOD FOR TRANSPARENT POLYARYLSULFONES
AUTHOR(S): A. Zweig, W.A. Henderson, N.D. Searle
CONTRACT NO: F33615-73-C-5168
CONTRACTOR: American Cyanamid Company
PROJECT MONITOR: E. Arvay (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The Air Force polyarylsulfone polymer is an exceptionally photosensitive plastic the degradation of which is manifested by ultraviolet, visible and infrared absorption spectral changes as well as haze development, changes in fluorescence, embrittlement and loss of impact strength. The wavelengths most effective in causing these events are in the short wavelength ultraviolet(310-330 nm) region corresponding to onset of strong absorption by the polymer itself. As the photochemical processes proceed, the rate of degradation slows but only after optical properties near the exposed surface have deteriorated to unacceptable levels. Protective UV light absorbing additives are the only effective means of reducing the photodegradation of this material. The absorbers should be concentrated at the exposed surface for optimum effectiveness. At most they can provide no more than a five- to tenfold decrease in rate of photodegradation of the polymer.

REPORT NO: AFML-TR-74-65, Part I AD B000 380L
ACCESS NO: 203,188 May 1974
TITLE: EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS
AUTHOR(S): N.J. Abbott, J.S. Panto
CONTRACT NO: F33615-73-C-5034
CONTRACTOR: Fabric Research Laboratories
PROJECT MONITOR: S. Schulman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A treatment which protects thermally stabilized polybenzimidazole (PBI) from the effects of repeated laundering was developed, providing retention of stability through 15 wash-dry cycles in alkaline detergent.

AFML/MB

REPORT NO: AFML-TR-74-65, Part II
ACCESS NO: 203,342 May 1974
TITLE: THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS
AUTHOR(S): N.J. Abbott, J.G. Donovan, M.M. Schoppee
CONTRACT NO: F33615-73-C-5034
CONTRACTOR: Fabric Research Laboratories
PROJECT MONITOR: S. Schulman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The tensile properties of Kevlar 29 and Kevlar 49, PRD-49 IV and PBI yarns were measured at low and high strain rates over the temperature range -65 to 800F. The effect of twist on tensile properties was determined also for Kevlar 29 and 49 yarns, as well as the knot and loop strengths of these yarns at various levels. Single fiber properties were measured for Kevlar 29 and Kevlar 49, including tensile properties, the effect of bending, twisting and lateral compression. Critical velocity under lateral impact and dynamic modulus was also determined.

REPORT NO: AFML-TR-74-66 AD B000 177L
ACCESS NO: 203,157 June 1974
TITLE: FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS
AUTHOR(S): R.C. Evers
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: R. Evers (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Novel fluorocarbon and fluorocarbon ether-bis (o-aminophenol) monomers were synthesized by a multistep route from the corresponding fluorocarbon and fluorocarbon ether-diiodides. The key reaction in this synthesis was achieved by the copper-catalyzed coupling of the diiodides with 4-iodophenyl-acetate under experimentally determined optimum reaction conditions. Polycondensation of the monomers with fluorocarbon ether diimidate esters led to linear, soluble fluorocarbon ether bibenzoxazole polymers whose structures were verified by elemental and infrared analysis. Based on the encouraging results gained in this investigation, the synthesis of additional fluorocarbon ether bibenzoxazole polymers with potentially broader use temperature ranges for evaluation as candidate materials for high temperature elastomer applications appear quite feasible.

REPORT NO: AFML-TR-74-76 AD B000 043L
ACCESS NO: 203,190 April 1974
TITLE: FUNDAMENTAL STUDIES ON REACTIVE OLIGOMERS
AUTHOR(S): G.F. D'Alelio
CONTRACT NO: F33615-72-C-1312
CONTRACTOR: University of Notre Dame

PROJECT MONITOR: F. Arnold (AFML/MBP)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A new aromatic diamine, bis [4-(3-aminophenoxy)phenyl] sulfone (BAPS-4,3) was prepared by hydrolysis of the precursor, bis [4-(3-acetamidophenoxy)phenyl] sulfone, whereas attempts to prepare the nitro-precursor of BAPS-4, 3 from the chlorophenyl sulfone and sodium nitrophenoxide were unsuccessful. 4-aminophthalonitrile was prepared in high purity by the catalytic reduction of 4-nitrophthalonitrile.

REPORT NO: AFML-TR-74-77
ACCESS NO: 203,125 April 1974
TITLE: EXPLORATORY DEVELOPMENT ON BASIC FAILURE BEHAVIOR OF ANISOTROPIC POLYMERIC MATERIAL
AUTHOR(S): E. M. Wu
CONTRACT NO: F33615-72-C-1514
CONTRACTOR: Washington University
PROJECT MONITOR: N. Pagano (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Crack extension in laminated composite has been analyzed by stress analysis of the crack through classical laminated plate analysis. Through such stress analysis, the stress vector acting on the periphery of a critical volume encapsulating the crack tip is obtained. This stress vector is compared to the strength vector which is independently determined by the tensor polynomial failure criterion. The comparison is made through polar representation of the stress and strength vector from the crack tip. Experimental results on a variety of lamination geometry and crack orientations supported the hypothesis that the coincidence of the stress and strength vector determine the crack propagation trajectory.

REPORT NO: AFML-TR-74-88 AD B000 277L
ACCESS NO: 203,166 May 1974
TITLE: DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES
AUTHOR(S): N. Bilow, R. Boschan, H. Raech
CONTRACT NO: F33615-73-C-5062
CONTRACTOR: Hughes Aircraft
PROJECT MONITOR: T. Aponyi (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Two systems were evaluated as adhesives which cure via addition reactions. These were (1) nitrile substituted polyphenyl ethers cured with terephthalonitrile N, N-dioxide (TPNO) and (2) acetylene terminated polyimide (HR600) cured thermally. The thermally cured acetylene terminated polyimide proved to be superior to the TPNO cured cyano substituted polyphenylene oxide. Lap-shear strengths of 6A14V titanium bonded with Al-filled specimens reinforced with heat cleaned 112 glass fabric and 2800 psi at ambient temperature, 2600 psi at 450F and 2100 psi at 500F on unfilled

specimens bonded with 70% HR600 prepreg on 112 heat-cleaned glass fabric. Weld-bonding of Ti specimens using Al powder filled HR600 adhesive proved to be successful and showed superior fatigue resistance over spot-welded specimens.

REPORT NO: AFML-TR-74-89, Part I AD 923 565L
ACCESS NO: 301,195 July 1974
TITLE: HIGH TEMPERATURE RESINS HAVING IMPROVED PROCESSABILITY
AUTHOR(S): N. Bilow, A. Landis
CONTRACT NO: F33615-73-C-5063
CONTRACTOR: Hughes Aircraft
PROJECT MONITOR: T. Aponyi (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734003
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Acetylene-terminated polyimides were synthesized and evaluated as polymer precursors which cure through addition. Homopolymers of these precursors yielded high strength (106,000 psi), high modulus ($4.5 \times 10^6$ psi), low void glass-reinforced laminates. High strength (as high as 276,000 psi), high modulus ($14 \times 10^6$ psi), low void unidirectional graphite fiber composites also were made. These composites, when post-cured to 600F and aged in air at 600F for 500 hours, retained 45% of their ambient temperature strength. As a result of the aging the 550F properties doubled over that of the non-aged specimens. Additional postcures on unaged specimens for one hour at 800F or up to 24 hours at 700F improved the high temperature retention of ambient temperature properties and provide excellent physical properties up to 700F. A laminate which received the 700F postcure had a 700F flexural strength of about 160,000 psi and a modulus of 14 million psi over the full 70F to 700F temperature range. This research demonstrated that readily processed 700F laminating resins, which cured through addition polymerization, were feasible to produce and opened up an entirely new area of resin technology.

REPORT NO: AFML-TR-74-92 AD B001 417L
ACCESS NO: 203,302 September 1974
TITLE: BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS
AUTHOR(S): J.K. Sieron
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: J. Sieron (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report describes the development of two promising classes of hydraulic system seal materials with increased broad temperature range capabilities. The first class dealt with development of methods for blending and co-vulcanizing fluorocarbon and fluorosilicone elastomers. Further improvements in physical properties and compression set resistance should make the blends strong candidates for long life seals with -65F to 350F capability. The second class of promising materials was based on

LD-487, an experimental DuPont fluoroelastomer. When compared to state-of-the-art fluoroelastomers, the new peroxide cured LD-487 compounds had an advantage of 20F on the low end and equivalent or superior resistance to degradation at 500 to 600F.

REPORT NO: AFML-TR-74-107 AD B000 731L
ACCESS NO: 203,214 October 1974
TITLE: EXPLORATORY DEVELOPMENT OF NEW AND IMPROVED SELF-SEALING MATERIALS FOR FUEL LINES
AUTHOR(S): R.M. Heitz, F. Hill
CONTRACT NO: F33615-73-C-5056
CONTRACTOR: Northrop Corporation
PROJECT MONITOR: T. Graham (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: New and improved self-sealing fuel line composites were developed under this program. Fabric reinforced plastic and nonflowering integrated aluminum foil, fabric reinforced laminated fuel line composites employing compressed natural rubber foam as the sealant were fabricated which successfully sealed wounds inflicted by .30 and .50 caliber projectiles. Results of pressure tests demonstrated the fabric reinforced plastic fuel line and certain fuel line composite based on plies of aluminum foil reinforced with plies of ballistic nylon fabric to be capable of withstanding hydraulic pressure in excess of 240 psi and resistant to distortion under vacuum. The compressed foam self-sealing concept utilizing plies of ballistic nylon for controlling damage was also investigated as a means of protecting standard aluminum fuel line tubing.

REPORT NO: AFML-TR-74-109 AD 922 172
ACCESS NO: 202,928 March 1974
TITLE: NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS
AUTHOR(S): K.B. Baucom
CONTRACT NO: F33615-72-C-1293
CONTRACTOR: PCR, Inc.
PROJECT MONITOR: R. Cochoy (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Nitroso rubber co- and terpolymers using CF3NO, CF2=CF2, CF2=CFCF=CF2, CF2=CFCOCF3, and C6F5NO as well as copolymers of vinylidene fluroide with hexafluoropropene and perfluoro(methyl vinyl ether) have been prepared. Monomers such as difluoromaleic anhydride, perfluoro-2,5-diazahexane-2, 5-dioxyl, alpha, omega-difunctional perfluoroalkylene oxides derived from tetrafluoroethylene oxide, perfluoro(methyl vinyl ether), pentafluoronitrosobenzene, and tris(3-cyanohexafluoropropyl)-s-triazine have been prepared and sent to Air Force Materials Laboratory.

AFML/MB

REPORT NO: AFML-TR-74-111 AD A001 609
ACCESS NO: 203,120 April 1974
TITLE: EXPLORATORY DEVELOPMENT ON FRACTURE MECHANICS OF COMPOSITE MATERIALS
AUTHOR(S): T. Cruse, J. Osias
CONTRACT NO: F33615-73-C-5055
CONTRACTOR: Carnegie-Mellon University
PROJECT MONITOR: J. Whitney (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The application of existing linear elastic fracture mechanics methodology to advanced fiber composite laminates is addressed both experimentally and analytically. The experimental portion of the study involved two test specimen geometries and ten orthotropic graphite/epoxy laminates. The experimental results indicate that valid fracture toughness values may be obtained with either specimen geometry, provided the length of the implanted crack exceeds a specified minimum value. The test data also show that the fracture toughness of an orthotropic fiber-dominated laminate may be predicted with some simple lamination theory models. The analytical portion of the study was directed toward the characterization of sharp cracks emanating from circular and elliptical holes. The analysis was performed numerically, using a modified form of the boundary-integral equations solution technique. The analytical results show that both the hole geometry and the laminate properties influence crack behavior. The results do not lend themselves to simple separation of these effects.

REPORT NO: AFML-TR-74-112 AD 922 176L
ACCESS NO: 202,933 July 1974
TITLE: DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING
AUTHOR(S): R.M. Stanton, D.E. Prince, T.L. Graham
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: J. Ross (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The concept of using an infrared reflective pigment coupled with an infrared transparent binder to improve the thermal protection characteristics of fire fighter's clothing is demonstrated. It is demonstrated that a lightweight (10 $oz/yd^2$) coated fabric can provide good thermal protection. Of the present formulations, the coating that appeared most suitable for the application consisted of a silicone binder coupled with an aluminum pigment.

REPORT NO: AFML-TR-74-115 AD B000 037
ACCESS NO: 203,121 July 1974
TITLE: EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS
AUTHOR(S): R. Lin, R. Ohnsorg, J. Economy, T. Pradelski

AFML/MB

CONTRACT NO: F33615-73-C-5086
CONTRACTOR: The Carborundum Company
PROJECT MONITOR: J. Ross (AFML/MBC)
PROJECT NO: 7320
TASK NO: 732001
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report summarizes the third year's effort, which was focused on bushing evaluation with the objective to develop a tool for drawing 3 to 4 micron continuous boric oxide multifilament yarn in order to reduce the time requirement for nitriding and to upgrade the fiber properties. Development activities included detailed evaluation of the 1000 tip bushing as well as the construction and evaluation of two 100 top bushings. Continuous nitriding studies with fine diameter boric oxide rovings were also performed. Limited amount of hot stretching was carried out for 6 micron fibers. Results obtained thus far indicate that the production of 3-4 micron continuous B203 filament yarn is technically feasible. The nitriding studies showed that a reduction of time needed in conversion can be greatly shortened with the fine diameter precursor fibers. In order to improve the handleability, increase in filament yarn size is an absolute necessity.

REPORT NO: AFML-TR-74-116
ACCESS NO: 203,044 June 1974
TITLE: ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES
AUTHOR(S): R. D. Schile
CONTRACT NO: F33615-72-C-1387
CONTRACTOR: Dartmouth College
PROJECT MONITOR: N. Pagano (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program is the determination of the state of stress in laminated, rectangular plates in which the individual plies are composed of fiber-reinforced, polymeric material. The starting point for the analysis is the three-dimensional theory of elasticity. The continuity conditions between plies are taken into account by means of an integral formulation of three-dimensional stress function theory. When the number of laminations is very large, a Correspondence Principle has been derived which relates the stress state in the laminated plate to that in a corresponding, homogeneous, anisotropic plate. For unsymmetrically laminated plates, equations governing the coupled bending and stretching deformation have been derived. Solutions of these equations are exhibited for the cases of loading by uniformly distributed edge forces and moments and a uniform temperature. An attempt was made to derive a theory describing the state of stress near the edges of a laminated plate where the stress distribution is three dimensional. Although technically successful, the resulting equations and boundary conditions are so complex that the corrected theory is not useful.

AFML/MB

REPORT NO: AFML-TR-74-118 AD 784 923
ACCESS NO: 202,918 March 1974
TITLE: LABORATORY TEST TECHNIQUES FOR EVALUATING THE THERMAL PROTECTION OF MATERIALS WHEN EXPOSED TO VARIOUS HEAT SOURCES
AUTHOR(S): E. D. Ernst
CONTRACT NO: F33615-72-C-1620
CONTRACTOR: University of Dayton
PROJECT MONITOR: J. Ross (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report presents the laboratory test techniques used for evaluating the thermal protection characteristics of materials when exposed to a number of heat sources. The parameters of prime importance are athermancy and thermal shrinkage. The techniques described, combined with an off-line data reduction package, provide a measure of materials thermal protection against human skin burns.

REPORT NO: AFML-TR-74-120 AD A000 383
ACCESS NO: 203,072 June 1974
TITLE: EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS
AUTHOR(S): A.P. Berens, P.E. Johnson, B.S. West
CONTRACT NO: F33615-72-C-2161
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: K. Jerina, R. Dauksys, G. Husman (AFML/MBC)
PROJECT NO: 7340
TASK NO: 734002
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Adhesively bonded joints were failed statically and in fatigue to test the validity of a fatigue life assessment model. The results of the tests were in agreement with both the assumptions and the predictions of the model. In particular, the failure mode was constant for all tests and the observed static strength and fatigue lives were adequately modeled by the Weibull family of distributions with constant, but different, shape parameters over the range of test conditions considered. The predicted relationship between the shape parameters as a function of an experimentally determined material property was observed. The predicted distribution of residual strength as a function of time in the fatigue environment was verified and agreement between prediction and observation for an accelerated fatigue test was obtained.

REPORT NO: AFML-TR-74-122, Part I AD B000 592L
ACCESS NO: 203,210 July 1974
TITLE: BIMATRIX ABLATIVE COMPOSITES. PART I: EVALUATION OF MATERIALS CONCEPTS
AUTHOR(S): R.W. Seibold, G.P. Johnson
CONTRACT NO: F33615-73-C-5139

CONTRACTOR: McDonnell Douglas Astronautics
PROJECT MONITOR: R. Farmer (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Three dimensionally reinforced bimatrix composites were developed with the goal of combining desirable properties of carbon-phenolic and carbon-carbon composites into a single material, resulting in potentially improved properties for thermal protection uses. The bimatrix composites consisted of three dimensionally woven carbon fabric reinforcement impregnated with a mixture of carbon and phenolic matrices. A study of phenolic resin pyrolysis mechanisms was conducted to select pyrolysis cycles for processing of the bimatrix composites. Four bimatrix composites and two reference carbon-phenolic composites were fabricated from loom woven 3-D carbon fabric preforms, using various processing modifications. Mechanical, physical, thermal, ablative, and impulse properties of various combinations of these composites were determined.

REPORT NO: AFML-TR-74-128
ACCESS NO: 202,974 June 1974
TITLE: AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS
AUTHOR(S): D.E. Earley
CONTRACT NO: F33615-72-C-1610
CONTRACTOR: University of Dayton
PROJECT MONITOR: H. Schwartz (AFML/MB)
PROJECT NO: 73400101
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An ADL-Strong arc imaging furnace was modified for ablation investigations of protection materials in thermal radiation environments. A wide range of irradiance levels were obtained by a defocusing technique. The modified arc image furnace was also shown to be useful for investigating materials in contamination-free environments involving vacuum, air or inert gas. The arc imaging furnace was demonstrated to be a versatile tool for research on thermal protection materials, such as fire protection fabrics and coatings, thermal flash resistant coatings, heat resistant paints, ablators, and for the study of crystalline materials at high heating rates.

REPORT NO: AFML-TR-74-134 AD B000 268L
ACCESS NO: 203,153 June 1974
TITLE: DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM
AUTHOR(S): R.W. Vaughan
CONTRACT NO: F33615-73-C-5094
CONTRACTOR: TRW Systems
PROJECT MONITOR: T. Reinhart, Jr. (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Two resin approaches were investigated for providing low resin flow, low pressure cure (vacuum bag pressure) graphite fiber

prepregs. These two approaches were based upon (a) TRW Systems HYSTL resin technology, and (b) aromatic amide or ester resins curing through novel end caps (DONA) developed under Contract F33615-72-C-2122. The HYSTL modified epoxy resin approach was selected as the most promising. This approach provided Hercules A-S graphite fiber reinforced composites that were vacuum bag molded, had low resin flow during molding, possessed good fiber orientation, and provided mechanical properties at elevated temperature and after high humidity exposure significantly higher to those obtained with autoclave molded state-of-the-art epoxy resin systems.

REPORT NO: AFML-TR-74-137 AD A003 671
ACCESS NO: 203,303 August 1974
TITLE: DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES
AUTHOR(S): R.D. Veltri, R.G. Bourdeau, F.S. Gaslasso
CONTRACT NO: F33615-73-C-5116
CONTRACTOR: United Aircraft
PROJECT MONITOR: W. Gloor (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Carbon ribbon from Kapton "H" film first produced in low width to thickness ratios from 5 to 15 was increased in width to ratios of 100 and over. The properties of carbon ribbon pyrolyzed at temperatures from 900C to 1250C were improved substantially by low rates of pyrolysis and a high degree of stretch during pyrolysis. Tensile strengths to 186,000 psi and moduli to 24.3 $(10)^6$ psi were obtained. The high temperature heat treatment of pyrolyzed ribbon resulted in a large increase in modulus with a lower increase in tensile strength. An alternate composite investigation with Kapton ribbon studied the effect of ribbon width and percent stretch in the ribbon on composite properties.

REPORT NO: AFML-TR-74-139 AD B000 124L
ACCESS NO: 203,122 May 1974
TITLE: DEVELOPMENT AND CHARACTERIZATION OF MATERIALS RESISTANT TO SUPERSONIC EROSION
AUTHOR(S): N. Wahl
CONTRACT NO: F33615-73-C-5057
CONTRACTOR: Textron's Bell Aerospace Co.
PROJECT MONITOR: G. Schmitt, Jr. (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Studies were carried out on sand or dust erosion resistant coatings for Ti alloys, rain erosion of transparent materials, bulk and reinforced composite ceramics, and the development of an ice crystal erosion capability in the AFML-Bell supersonic erosion test apparatus.

The comparative sand erosion studies on coatings for Ti-6Al-4V indicate that coatings of Ti boride, Fe boride, and a proprietary boride coating of Chromalloy Corp. merit further evaluation. The Chromalloy boride coating exhibited a 400% increase in erosion resistance as compared to uncoated Ti. Bulk ceramic materials such as hot pressed silicon nitride and boron nitride were evaluated for rain erosion resistance. The silicon nitride exhibited no erosion for extended periods of time at supersonic speeds. Boron nitride showed rapid erosion when tested at subsonic speed. Composite ceramic materials of 3D quartz-ceramic tested in rain at subsonic speeds exhibited high rates of erosion. Various methods of generating snow or ice crystals were examined and the use of a Ratnick snow gun was selected.

REPORT NO: AFML-TR-74-140 AD 784 789
ACCESS NO: 202,925 July 1974
TITLE: STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS
AUTHOR(S): P.C. Opt, J.H. Ross
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: P. Opt (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes and gives results of tests performed to measure the propensity of a series of Air Force flight and ground crew summer and winter garments and hospital garments. Garments tested were made of cotton, Nomex, nylon, 99% Nomex/1% stainless steel, 65% cotton/35% polyester, and experimental fibers of PBI and HT-4. Tests were limited to the measurement of static potential (voltage) after body movement, rubbing contact, and separation of garments worn by test subjects. Tests were conducted in an environmental chamber at 70F, 20-22% RH and 70F, 50-55% RH.

REPORT NO: AFML-TR-74-150 AD B000 593L
ACCESS NO: 203,211 July 1974
TITLE: CORROSION CONTROL AT GRAPHITE/EPOXY-ALUMINUM AND TITANIUM INTERFACES
AUTHOR(S): D.G. Treadway
CONTRACT NO: F33615-74-C-5052
CONTRACTOR: General Dynamics, Convair Division
PROJECT MONITOR: D. Prince (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A test program was conducted to develop and evaluate corrosion protection systems for use on graphite/epoxy-titanium joints. The joint specimens were prepared in duplicate and protected with several corrosion protection systems including epoxy polyamide primer, inhibited polysulfide sealant, and a linear polyurethane topcoat. All specimens were subjected to cyclic tension loading at -650F to induce typical topcoat cracks around fasteners followed by one week of 100% humidity at

120F and four weeks of exfoliation slat spray at 120F. It was concluded that graphite/epoxy-aluminum and titanium interface areas demanded careful corrosion protection, but conventional materials and techniques were adequate. The joint strength of the specimens tested were not degraded by exposure to a corrosive environment, with the exception of one adhesively bonded specimen.

REPORT NO: AFML-TR-74-151 AD B000 273L
ACCESS NO: 203,159 August 1974
TITLE: HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS PRECURSORS
AUTHOR(S): G.K. Layden
CONTRACT NO: F33615-73-C-5131
CONTRACTOR: United Aircraft Corporation
PROJECT MONITOR: R. Farmer (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Single phase fibrous carbon specimens were produced by the pyrolysis of hot compacted, partially stabilized polyacrylonitrile precursor fibers. Both small unidirectionally oriented continuous filament compacts, and randomly oriented chopped fiber specimens up to 1.9 inches in diameter and 0.7 inch in height were studied. Test pieces cut from billets in orientations normal and parallel to the pressing directions have been characterized in terms of thermal expansion, thermal conductivity, flexural, shear, and compressive strength, Young's modulus, and strain to failure, and the results compared with a number of high performance graphites and carbon/carbon composites.

REPORT NO: AFML-TR-74-157 AD B000 178L
ACCESS NO: 203,123 August 1974
TITLE: HIGH TEMPERATURE POLYMERIC COATING MATERIALS
AUTHOR(S): P.F. Radice, P. Nannelli
CONTRACT NO: F33615-72-C-1662
CONTRACTOR: Pennwalt Corp.
PROJECT MONITOR: D. Prince (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Coating formulations based on zinc and zirconium phosphinate polymers have been the subject of evaluation and optimization. The effort was a continuation of a previous study in which a number of poly (metal phosphinate) compositions were shown to have promise in high temperature coating application. The formulations with the best overall performance dried at room temperature into hard cohesive coatings which retain good overall properties at temperatures up to 1000F, including integrity, functionality, color retention, abrasion resistance, wet adhesion, and resistance to fluids.

AFML/MB

REPORT NO: AFML-TR-74-167
ACCESS NO: 203,167 June 1974
TITLE: FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES
AUTHOR(S): J. Mandell, S. Wang, F. McGarry
CONTRACT NO: F33615-73-C-5169
CONTRACTOR: Massachusetts Institute of Technology
PROJECT MONITOR: R. Dauksys (AFML/MBC)
PROJECT NO: FY1457730 0715
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The fracture of thin, prenotched graphite/epoxy laminates has been studied analytically and experimentally. In the analytical portion of the study, solutions were obtained for the three-dimensional stress field at the tip of both a sharp crack and a crack with a subcritical damage zone at its tip. The solutions were obtained using a three-dimensional hybrid stress model finite element analysis formulated through the Hellinger-Reisner variational principle, which was developed during the course of the project. The stress distributions and mechanisms of stress transfer are discussed for the two solutions, both of which model a 90/0/0/90 crossplied laminate. The experimental portion investigated the extension of crack-tip damage zones and the final fracture characteristics of graphite/epoxy laminates of several ply configurations. Emphasis was placed on studies of the effects of specimen size, laminate thickness, ply thickness, and ply stacking sequence. The effects of varying the type of fiber in 0/90 laminates were also investigated for glass, graphite, Kevlar, and boron fibers.

REPORT NO: AFML-TR-74-169 AD B001 163L
ACCESS NO: 203,261 November 1974
TITLE: IMPROVED FATIGUE STRENGTH ADHESIVE
AUTHOR(S): D.K. Klapprott
CONTRACT NO: F33615-73-C-5133
CONTRACTOR: Dexter Corporation
PROJECT MONITOR: T. Aponyi (AFML/MBC)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: In spite of their high static strengths over the temperature range of -67F to 350F, adhesives presently used by the aircraft industry limit structural design loadings to as little as 20% of static properties if fatigue lives on the order of $10^7$ cycles are needed. Recent work with composites has shown that an increase in fiber modulus greatly increases fatigue loading limits. Related increases in fatigue resistance on inclusion of high modulus fibers in adhesives bondlines have also been observed in work of the Air Force Materials Laboratory. Continued development of this concept with examination of bond line parameters such as resin and fiber type, fiber/resin volume ratio, fiber-fabric construction and fabric orientation, has confirmed and defined such fatigue improvement in high-modulus fiber reinforced adhesives. A fifty-fold increase in fatigue life at equivalent stress levels was achieved when a woven high modulus graphite fabric was substituted for the conventional nylon knit support in a 350F service adhesive.

REPORT NO: AFML-TR-74-175
ACCESS NO: 203,258 September 1974
TITLE: ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY
AUTHOR(S): M.B. Chamberlain, W.L. Baun
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: W. Baun (AFML/MBM)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A study on the suitability of utilizing a soft x-ray appearance potential spectrometer as a measurement tool for characterizing elemental and chemical species on solid surfaces has been completed. Two principal objectives of the research have been (1) to assess such characterization capabilities for analysis of materials that are of interest to ongoing research and development programs of the Air Force Materials Laboratory and (2) to demonstrate experimental techniques which improve the instrumentation.

REPORT NO: AFML-TR-74-176
ACCESS NO: 203,305 October 1974
TITLE: FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS
AUTHOR(S): D.R. May, Jr.
CONTRACT NO. internal
CONTRACTOR: N/A
PROJECT MONITOR: J. Ross (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A comparative analysis of five potential uniform fabrics with the currently authorized Cloth, Tropical, Polyester/Wool, Specification MIL-C-21115F and Cloth, Serge, Polyester/Wool, Specification MIL-C-83048 was conducted to determine their relative suitability for dress uniform application. The five materials consist of two woven texturized fabrics and three knit fabrics. On the basis of this evaluation, the texturized fabrics possess properties and attributes befitting a uniform material while the knit's high propensity to snagging and picking detracts from its potential as such.

REPORT NO: AFML-TR-74-180 AD A001 086
ACCESS NO: 203,076 August 1974
TITLE: ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS
AUTHOR(S): G. Springer, C. Yang
CONTRACT NO: F33615-72-C-1563
CONTRACTOR: University of Michigan
PROJECT MONITOR: G. Schmitt (AFML/MBE)
PROJECT NO: 7340
TASK NO: 734007

DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The behavior of both uncoated and coated fiber reinforced composite substrate systems subjected to repeated impingements of liquid droplets was investigated. The system studied consisted of an uncoated fiber reinforced composite, and a fiber reinforced composite covered by a single layer of homogeneous coating of arbitrary thickness. A macroscopically anisotropic model was developed to approximate the elastic behavior of the fiber reinforced composite. Based on the uniaxial stress wave model, the variations of the stresses with time in the coat-substrate system were determined both in the coating and in the substrate. Employing the fatigue theorems established for the rain erosion of homogeneous materials, algebraic equations were derived for both systems which describe the incubation period, rate of mass removal, and the total mass loss. The results were compared to available experimental data and good agreement was found between the present analytical results and the data.

REPORT NO: AFML-TR-74-181
ACCESS NO: 203,079 September 1974
TITLE: PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS
AUTHOR(S): K.R. Mecklenburg
CONTRACT NO: F33615-72-C-1374
CONTRACTOR: Midwest Research Institute
PROJECT MONITOR: F. Brooks (AFML/MBT)
PROJECT NO: 7340 and 7343
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Operational data on six lubricant compact materials, installed in nine ball bearings, are presented. The compact materials are described and the formation process is outlined. A description of the test rigs used is presented. The two basic types of ball bearing test specimens are described, as are the two ball separator designs. The compact inserts were either cylindrical or conical and were installed in either Al or Ti separators. The operating life results are presented, with the compact materials classified as either "early failure" or "prolonged operation." Three materials permitted bearing operation for less than 1600 hours, while the other three materials have been operating for over 20,000 hours each in five bearing specimens. Weight loss data are presented, from which wear rate data were calculated. Frictional torque measurements are included, as are the vacuum levels in the test chambers. Operational wear lives were predicted for the five bearings still operating using a conservative quantity of available compact material and the calculated wear rates. Conclusions relative to the compact materials and bearing performance are included.

REPORT NO: AFML-TR-74-182 AD 787 850
ACCESS NO: 203,304 September 1974
TITLE: EXPLORATORY DEVELOPMENT OF POLYUREYLENE/ACYLSEMICARBAZIDE RESINS

AUTHOR(S): W.P. Fitzgerald, I. Petker
CONTRACT NO: F33615-73-C-5174
CONTRACTOR: Structural Composites Industries, Inc.
PROJECT MONITOR: T. Reinhart, Jr. (AFML/MBC)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The reaction between hydrazine and trimesoyl hydrazine (TMH) with diisocyanate-capped polyether to form polyureylene/acylesemicarbazide resin were studied. The products of these reactions, particularly that involving the cross-linking potential of the tri-functional TMH, appeared to have significant theoretical potential for low flow laminating resins. Reactions with hydrazine were all spontaneous,leading to a variety of elastomeric materials which exhibited no tendency for crosslinking. It was not possible to obtain reaction with TMH and no rigid materials were observed. Although the cause of this difficulty is not understood, it appeared that very low solubility and possibly the low reactivity of the isocyanate materials may have been the primary causes of the problem.

REPORT NO: AFML-TR-74-185
ACCESS NO: 203,181 May 1974
TITLE: A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS
AUTHOR(S): C.E. Arthur, A.S. Heller, A.B. Thakker
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: The complex modulus of boron/epoxy and graphite/epoxy laminates has been measured in forced vibration tests at frequencies ranging from 20 to 17000 Hz and temperatures varied between -50F and 300F. The data was analyzed using response surface methodology. Based on the response surface time-temperature shift parameters, master curves, and probability relations have been developed.

REPORT NO: AFML-TR-74-189, Part I
ACCESS NO: 203,343 December 1974
TITLE: ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS. PART I: DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE
AUTHOR(S): J.C. Tyler
CONTRACT NO: F33615-73-C-5123
CONTRACTOR: Southwest Research Institute
PROJECT MONITOR: M. Rivera, R. Benzing (AFML/MBT)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report presents a summary of the first year's effort in a two-year program to study the influence of the oil film thickness on lubricant film behavior and bearing-lubricant life expectancy in despin mechanical assembly-type bearings operating in vacuum. Experimental and

analytical work that has been performed on the development of a technique to measure the oil film thickness in an actual bearing operating in vacuum is described. Preliminary tests with actual bearings show that this technique, involving the measurement of the displacement of the bearing race due to the development of elastohydrodynamic oil films at the ball-race conjunctions, will be satisfactory. In addition to the bearing tests, rather extensive comparisons of the elastohydrodynamic film thickness measurements have been made by both the displacement technique and the optical interference technique in an SwRI optical tester involving a rotating ball placed between two glass disks.

REPORT NO: AFML-TR-74-195 AD A004 200
ACCESS NO: 203,255 October 1974
TITLE: DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES
AUTHOR(S): A.J. 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 a falling weight viscometer at temperatures of 100, 210, and 300F 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.

REPORT NO: AFML-TR-74-196
ACCESS NO: 203,306 September 1974
TITLE: MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES
AUTHOR(S): R.C. Novak
CONTRACT NO: F33615-73-C-5090
CONTRACTOR: United Aircraft
PROJECT MONITOR: G. Husman (AFML/MBC)
DIST. STATEMENT: U.S. Govt. 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.

AFML/MB

REPORT NO: AFML-TR-74-199 AD B001 643L
ACCESS NO: 203,337 November 1974
TITLE: SYNTHESIS OF HIGH MOLECULAR WEIGHT 'PARA'-PHENYLENE PBI
AUTHOR(S): R.I. Kovar, F.E. Arnold
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: F. Arnold (AFML/MBP)
DIST. STATEMENT: U.S. Govt. 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-74-208, Part I
ACCESS NO: 203,416 November 1974
TITLE: WATER-BASE COATINGS
AUTHOR(S): M.S. El-Aasser
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-74-209 AD B000 667L
ACCESS NO: 203,216 October 1974
TITLE: INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS
AUTHOR(S): H.Y.B. Mar, P.B. Zimmer
CONTRACT NO: F33615-74-C-5006
CONTRACTOR: Honeywell
PROJECT MONITOR: J. Weaver (AFML/MBE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The objectives of this program were to define optimum, practical coating systems with enhanced infrared and thermal protection capabilities and develop a preliminary specification for infrared and thermal camouflage coatings. Coating systems were developed with high visible and near infrared reflectance, thermally stable to 350F, room temperature cure, color tailorability,and durable to the operational environment. A new high temperature, high infrared diffuse reflectance, one-component oxime-cured silicone coating system was optimized and

evaluated. Four coating systems were pigmented to match Federal Standard color numbers for black, gray, olive drab, and white. Coated test panels were prepared with each coating system and subjected to environmental tests. This test data was used to develop a preliminary coating specification.

REPORT NO: AFML-TR-74-210 AD A002 876
ACCESS NO: 203,204 September 1974
TITLE: ANALYSIS OF MULTIPLE PARTICLE IMPACTS ON BRITTLE MATERIALS
AUTHOR(S): W.F. Adler
CONTRACT NO: F33615-71-C-1528
CONTRACTOR: Bell Aerospace (Textron)
PROJECT MONITOR: G. Schmitt, Jr. (AFML/MBE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: An analytical model for the prediction of the material removed by particle impingement has been developed based on the concept of erosion pit nucleation and growth. This model is a general representation of the erosion process for a number of materials exposed to both rain and solid particle environments. The primary objective of the current program has been to obtain explicit expressions for the equations governing the material removal process for glass plates subjected to multiple impacts by glass beads. The glass plates exhibit elastic brittle behavior when subjected to localized pressures, which simplifies the form of the material response; and the use of glass beads provides a definable erosive medium. The general model has been evaluated under these conditions.

SYSTEMS SUPPORT DIVISION (AFML/MX)

REPORT NO: AFML-TR-73-187
ACCESS NO: 202,986 August 1973
TITLE: HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER
AUTHOR(S): B. E. Richards
CONTRACT NO: F-61052-70-C-0031
CONTRACTOR: Von Karman Institute
PROJECT MONITOR: G. Denman (AFML/MXS)
PROJECT NO: 7381-02
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Heat transfer rates, using calorimeter sensors, and pressures, using variable reluctance diaphragm transducers, have been measured on five model shapes in the VKI Longshot facility at mach numbers on 15 and 20 and over a unit Reynolds number range of $2 \times 10^6$ to $7 \times 10^6$ per foot. Two basic shapes, a hemisphere and a $50^\circ$-$8^\circ$ half-angle biconic configuration with and without nose bluntness, were tested with different surface roughness.

REPORT NO: AFML-TR-73-195
ACCESS NO: 202,945 August 1973
TITLE: DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS
AUTHOR(S): R.B. Urzi
CONTRACT NO: F33615-72-C-1838
CONTRACTOR: Lockheed Aircraft Corporation
PROJECT MONITOR: A. Brisbane (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A multiple task program was implemented to aid in the establishment of a military test standard needed to evaluate joint fatigue life improvement fasteners in fatigue and to generate joint fatigue data utilizing the two most commonly used "fatigue rated" fastener systems. The major task consisted of fatigue testing 1008 elemental joint specimens using the two basic types of elemental joint specimen. Within this program six important fastener system variables were investigated: (1) fastener configuration; (2) fastener material; (3) amount of interference fit; (4) faying surface treatment; (5) sheet thickness/fastener diameter ratio; (6) fastener hole fabrication methods. The test methods were those proposed for insertion into MIL-STD-1312 "Fastener Test Methods." These methods were in general satisfactory in the assessment of the fatigue behavior of the joint system tested.

AFML/MX

REPORT NO: AFML-TR-73-255, Volume I — AD 917 534L
ACCESS NO: 202,570 — February 1974
TITLE: THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS
AUTHOR(S): H.S. Starrett, F.C. Weiler, C.D. Pears
CONTRACT NO: F33615-71-C-1566
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: G. Hollenberg (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Experimental and analytical investigations were performed relative to defining the thermostructural response of Mod 3a carbon-carbon material. The experimental effort was aimed toward defining behaviors which would be expected to have a first order effect on the thermostructural predictions. These include off axis stress-strain behavior, high temperature visco-elastic behavior, and property degradation as a result of thermostructural loading.

REPORT NO: AFML-TR-73-283 — AD 779 676
ACCESS NO: 202,678 — December 1973
TITLE: ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT
AUTHOR(S): W.E. Berner
CONTRACT NO: F33615-72-C-1282
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: P. House (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Information is needed on the environmental aging of various candidate fire suppressant dry bay materials. This includes resistance to water, fuel, lubricating oil, hydraulic fluid, and heat. Three rigid materials and five flexible materials were subjected to environmental testing. The best rigid material and the best flexible material for this purpose are identified.

REPORT NO: AFML-TR-73-300 — AD 917 409L
ACCESS NO: 202,537 — February 1974
TITLE: INCREASING DESIGN ALLOWABLES FOR A GRAPHITE
AUTHOR(S): H.S. Starrett, H.G. Sanders, J.R. Brown, Jr., C.D. Pears
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: C. Pratt, E. Ross (AFML/MXS)
PROJECT NO: 7381
TASK NO: 738102
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report is the final report covering work on a subtask under contract number F33615-72-C-1591, "Design Data on Reentry

Materials for Heatshield and Nosetip Application." This task was concerned with the evaluation of comprehensive NDT and billet truncation on the design allowable strain of a graphite nosetip material. The material used for this evaluation was an ATJ-S graphite manufactured in shapes 3.0 inches in diameter by 8.0 inches long and designated P-Billets. The application of the comprehensive NDT raised the 95/95 design allowable of the material by 0.0005 in./in. and raised the minimum values by over 0.001 in./in. in both with and across grain directions and eliminated the inferior billets from the population.

REPORT NO: AFML-TR-73-306 AD 919 443L
ACCESS NO: 202,692 November 1973
TITLE: EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM
AUTHOR(S): T.T. Matoi
CONTRACT NO: F33615-73-C-5126
CONTRACTOR: Rockwell International
PROJECT MONITOR: J. Rhodehamel (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report presents the design philosophy and a description of the exploratory development and testing of a large cross section boron/aluminum metal matrix advanced composite longeron component. The feasibility of using a selectively reinforced boron/aluminum structural design which could be mechanically fastened and tested as a load bearing airframe member was demonstrated. A description of the fabrication and testing of the boron/aluminum longeron demonstration component is presented. The results of a representative coupon, joint element tests, and static tests involving a representative longeron specimen are discussed. Also, a cost/weight trade study is presented which indicates the cost competitiveness of using a boron/aluminum metal matrix in lieu of the boron/epoxy-plus-titanium-strap configuration.

REPORT NO: AFML-TR-73-310 AD 777 177
ACCESS NO: 202,556 January 1974
TITLE: ENGINEERING DESIGN DATA FOR ALUMINUM ALLOY 2124-T851 THICK PLATE
AUTHOR(S): K.A. Fudge, R.E. Jones
CONTRACT NO: F33615-72-C-1282
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: D. Watson (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Tensile, fracture, fatigue, fatigue crack growth, and stress corrosion properties for aluminum alloy 2124-T851 thick plate were determined. The material was obtained from the Aluminum Company of America. Material property comparisons were then drawn between the 2124-T851 alloy and its parent alloy, 2024, in the T851 condition. A comparison of the

mechanical properties of aluminum alloy 2124-T851 and 2024-T851 revealed that the 2124-T851 alloy exhibited similar tensile properties with possibly less short transverse ductility, superior fracture toughness, comparable fatigue properties with slightly lower smooth fatigue resistance, and identical fatigue crack growth rates. The 2124-T851 alloy also demonstrated good stress corrosion resistance.

REPORT NO: AFML-TR-74-1
ACCESS NO: 203,202 January 1974
TITLE: DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER
AUTHOR(S): A.J. Murphy
CONTRACT NO: F33615-70-C-1704
CONTRACTOR: Aerotherm Division of Acurex
PROJECT MONITOR: G. Denman (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: An experimental method of determining heat transfer rates to calorimeter models tested in the AEDC Aeroballistics facility has been developed. Heating rates up to 15,000 Btu/ft$^2$-sec were measured at Mach numbers approaching 14. Stagnation pressures of 130 atmospheres and enthalpies of 5100 Btu/lbm were achieved. An extensive analysis of smooth-wall test data generated is described. Exact numerical boundary layer predictions were found to be in agreement with the test results. Heating rates were estimated to be measured within $\pm$ 10 percent. Roughness effects on heating were measured for a variety of roughness heights common at reentry conditions. Currently used roughness correlations were found to be in agreement with the data.

REPORT NO: AFML-TR-74-26
ACCESS NO: 201,807 March 1974
TITLE: DURABILITY OF ADHESIVE BONDED JOINTS
AUTHOR(S): T.B. Frazier, A.D. Lajoie
CONTRACT NO: F33615-71-C-1668
CONTRACTOR: Bell Helicopter Company
PROJECT MONITOR: W. Scardino (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The purpose of this program performed under Air Force Contract F33615-71-C-1668 has been to develop data on the mechanical properties of adhesives in metal-to-metal, composite-to-composite, and honeycomb bonds and to investigate the influence of various adherend surface preparation methods on mechanical properties.

REPORT NO: AFML-TR-74-39, Supplement I AD B001 587L
ACCESS NO: 203,222 January 1975
TITLE: THE CARBON-CARBON ASSESSMENT PROGRAM, SUPPLEMENT I (APPENDIX A), MATERIALS CHARACTERIZATION
AUTHOR(S): J.K. Legg
CONTRACT NO: F33615-72-C-1591

CONTRACTOR: Southern Research Institute
PROJECT MONITOR: C. Pratt, E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Six candidate carbon-carbon materials were evaluated for mechanical, thermal, and thermostructural response. Nosetip ground test specimens were sectioned and damage related to mechanical testing observations by nondestructive testing techniques. Overall observations relating to the survivability of these materials in the thermostructural environment are given.

REPORT NO: AFML-TR-74-39, Supplement V AD B001 588L
ACCESS NO: 203,222 January 1975
TITLE: THE CARBON-CARBON ASSESSMENT PROGRAM, SUPPLEMENT 5, (APPENDIX E) FAILURE ANALYSIS
AUTHOR(S): J.K. Legg
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: C. Pratt, E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: The properties of six carbon-carbon materials were reduced to input form for computer codes to predict the thermostructural response of the materials in the Southern Research temperature/stress test. The predicted responses were compared against measured responses. The differences were taken as an indication of nonlinear response and degradation. The degradation in the T/S specimen was used as a baseline in the post test inspection of nosetips evaluated in El Toro nosetips showed good correlation with the observation made on T/S specimens.

REPORT NO: AFML-TR-74-49
ACCESS NO: 202,682 March 1974
TITLE: MECHANICAL PROPERTIES OF Ti-6Al-4V ANNEALED FORGINGS
AUTHOR(S): R.R. Cervay
CONTRACT NO: F33615-72-C-1282
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: D. Watson (AFML/MXE)
PROJECT NO: 7381
TASK NO: 738106
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Tests were conducted to determine the mechanical properties of titanium 6Al-4V annealed forgings. Tensile, fracture toughness, and constant amplitude cyclic crack growth properties were obtained along with limited corrosion studies of fastener installation. The tensile properties were determined for three orientations and the fracture toughness properties for four orientations. Some of the tensile and fracture toughness specimens were subjected to a time-temperature exposure before being tested at room temperature. The mechanical properties of the annealed material were similar to those in the literature. The time-temperature exposure cycle slightly altered the mechanical properties of the material. The corrosion tests conducted on the fastener installations did not produce any cracking in the material under the test conditions.

AFML/MX

REPORT NO: AFML-TR-74-55
ACCESS NO: 202,593 April 1974
TITLE: EVALUATION OF Ti-3Al-2.5V TITANIUM ALLOY HYDRAULIC TUBING
AUTHOR(S): L.R. Sanders
CONTRACT NO: F33615-72-C-1923
CONTRACTOR: McDonnell Aircraft Co., McDonnell Douglas Corp.
PROJECT MONITOR: L. Gulley (AFML/MXA)
PROJECT NO: 7381
TASK NO: 738107
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program was to investigate the effect of manufacturing parameters used to produce annealed, and cold-worked and stress-relieved Ti-3Al-2.5V tubing. The basic test used in the evaluation was rotary flexure fatigue. It was shown that grit blasting of the tubing's inside diameter (I.D.) surface or glass bead peening of the tubing's outside diameter (O.D.) surface offers no improvement in fatigue life. The best surface conditioning method was determined to be: O.D. lightly belt polished (400 grit), I.D. and O.D. chemically milled. The balance of the program was devoted to determining the effect of tubing imperfections.

REPORT NO: AFML-TR-74-67 AD 783 616
ACCESS NO: 202,870 May 1974
TITLE: THE COLLECTION, GENERATION, AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA
AUTHOR(S): P.E. Ruff, W.S. Hyler
CONTRACT NO: F33615-73-C-5053
CONTRACTOR: Battelle Columbus Laboratories
PROJECT MONITOR: C. Harmsworth (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This annual report describes highlights of some of the work performed by Battelle's Columbus Laboratories, a contractor to the Air Force Materials Laboratory, to update MIL-HDBK-5. Included is a description of work performed in the areas of fatigue, fatigue-crack-propagation, plain-strain fracture toughness, plane-stress fracture toughness, stress corrosion, fasteners, design allowable properties for aluminum castings, stress-strain curves, and physical properties.

REPORT NO: AFML-TR-74-102
ACCESS NO: 202,857 May 1974
TITLE: EVALUATION OF SHEAR-SPUN Ti-3Al-2.5V TITANIUM ALLOY HYDRAULIC TUBING
AUTHOR(S): L.R. Sanders
CONTRACT NO: F33615-72-C-1923
CONTRACTOR: McDonnell Douglas Corporation
PROJECT MONITOR: L. Gulley (AFML/MXA)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The objective of this program was to evaluate hydrostatically extruded Ti-3Al-2.5V hydraulic tubing. However, due to the inability of

the tubing supplier to produce extruded tubing, "shear spun" tubing was substituted for evaluation. Tests conducted on the shear-spun tubing included rotary flexure and impulse fatigue, flaring, bending, flattening, and tensile strength. The shear-spun tubing was found to be inferior to conventionally produced tubing because of poor surface finish.

REPORT NO: AFML-TR-74-103 AD 786 470
ACCESS NO: 202,995 May 1974
TITLE: FILAMENT WOUND 67-GALLON TANK FOR AQM-34M AIRCRAFT
AUTHOR(S): D. Abildskov, L. Ashton, R. Lyman
CONTRACT NO: F33615-71-C-1788
CONTRACTOR: Fiber Science, Inc.
PROJECT MONITOR: E. Morrisey (AFML/MXE)
PROJECT NO: 7381/01/31
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The effort was successfully completed in that a total of 13 filament wound, glass-reinforced-plastic wing tanks with rotationally-cast liners were fabricated. The process of using rotationally-cast liners of fuel resistant thermoplastics and filament winding thereon appears to be a significant advancement and shows great promise as a means of reducing the cost of filament wound tanks. Previously (see AFML-TR-70-4) a thermoformed liner was produced from extruded tubing and many ancillary pieces. The best fuel resistant thermoplastics are not amenable to the thermoforming process. The rotamolded liner concept simplified the liner subassembly before winding and provided the opportunity to utilize materials with greater fuel resistance than the previous approach based on forming the liner from extruded tubing.

REPORT NO: AFML-TR-74-125
ACCESS NO: 202,985 June 1974
TITLE: EVALUATION OF ELASTOMERS, PLASTICS, COATINGS, AND METALS
AUTHOR(S): D.A. Gerdeman, W.E. Berner, G.J. Petrak
CONTRACT NO: F33615-72-C-1282
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: A. Olevitch
PROJECT NO: 7381
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This report describes the evaluation of a variety of materials and related engineering efforts completed under contract to the Materials Support Division of the Air Force Materials Laboratory. The report is divided into two sections, one covering the mechanical properties of metals and the other the evaluation of nonmetallic materials. Included is a program to determine the fracture and crack growth properties of the primary structural materials, HP 9Ni-4CO-20C steel, 2024-T851 aluminum, and Ti-6Al-4V titanium for the B-1. Other system support programs included the evaluation of landing gears fabricated from 7175-T736 and 7049-T73 and special tensile and elongation measurements of bolts. Engineering design data were obtained for 10 Ni (HY-180) steel and 7475 and 7050 aluminum. Also described are a computer program for analyzing crack growth data and studies of fatigue crack growth retardation and fatigue crack starter defects.

AFML/MX

REPORT NO: AFML-TR-74-133
ACCESS NO: 203,346 October 1974
TITLE: FRACTURE MECHANICS TESTS AND ANALYSES OF THE AEDC APTU STORAGE VESSEL MATERIAL
AUTHOR(S): A.W. Gunderson
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: A. Gunderson
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A test program to evaluate cyclic crack growth rates and residual strengths of flawed panels has been completed. The test specimens were from representative high pressure air storage tanks similar to those used in the AEDC APTU test facility. The test results reported herein, coupled with the proof test performed at AEDC, provide the data base to use a proof test logic methodology for estimating the minimum cyclic life of the storage tank field.

REPORT NO: AFML-TR-74-147 AD 923 566
ACCESS NO: 203,071 July 1974
TITLE: STUDY OF RELAMINARIZATION ON ATJ-S GRAPHITE THERMO-STRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY
AUTHOR(S): A.D. Anderson, M.D. Jackson
CONTRACT NO: F33615-72-C-1519
CONTRACTOR: Acurex Corporation
PROJECT MONITOR: C. Budde (AFML/MXS)
PROJECT NO: 7381
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: A criterion has been established for defining boundary layer relaminarization on sphere cone or blunt models. This criterion is applicable when the boundary layer transition is dominated by surface roughness which is the case for nosetip materials of current interest. The baseline criterion was developed through a correlation of experimental heat transfer data obtained under the Passive Nosetip Technology program. This criterion also correlates relaminarization regions of the heat transfer distributions obtained from experimental data on ATJ-S graphite models tested in the AFFDL 50 MW facility as part of a thermostructural test series. The effect of the boundary layer relaminarization is to reduce the heat flux to the model in the vicinity of the tangency point between the blunt or spherical nose and the conical afterbody. This reduction in heat flux impacts the thermostructural response of the nosetip material.

REPORT NO: AFML-TR-74-148 AD B000 498L
ACCESS NO: 203,193 December 1974
TITLE: MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE, A STRUCTURE COMPOSED OF CC MATERIAL
AUTHOR(S): A.D. Cull, S.G. Bapat, H.S. Starrett
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute

PROJECT MONITOR: E. Ross, C. Pratt, Jr.
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This program was an initial screening in an attempt to fit this heatshield "material" into the earlier Air Force Advanced Heatshield Program. The mechanical properties of Truss-Core are average insofar as they invariably fall between the extremes of the other AHP materials. Thermal expansion data indicate that Truss-Core is essentially isotropic in the axial and circumferential directions. Thermal conductivity data are consistent with carbon type behavior.

REPORT NO: AFML-TR-74-161 AD B001 003L
ACCESS NO: 203,227 January 1975
TITLE: MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE
AUTHOR(S): J.K. Legg, S.G. Bapat
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: C.Pratt, E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Mechanical and thermal properties of AGSR graphite were determined. The mechanical properties were tensile and compressive ultimate strengths, initial elastic moduli, and strains-to-failure, torsional ultimate strengths, and shear moduli. Thermal properties determined were thermal conductivity and thermal expansion. The tensile and compressive properties were determined at room temperature, 2500F, 3500F, and 4500F. Three compressive specimens were tested at 5000F. Torsional properties were determined at room temperature, 2500F, and 4500F. Thermal conductivities and thermal expansions were determined from room temperature to 5000F.

REPORT NO: AFML-TR-74-207
ACCESS NO: 203,389 September 1974
TITLE: IMPROVED INSULATOR MATERIALS REQUIREMENT PROGRAM
AUTHOR(S): R.P. Gilliam, S.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. 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-74-211 AD B000 594L
ACCESS NO: 203,223 December 1974
TITLE: MECHANICAL AND THERMAL PROPERTIES OF MOD 3a, A PIERCED FABRIC CARBON-CARBON MATERIAL
AUTHOR(S): J.K. Legg, C.D. Pears
CONTRACT NO: F33615-72-C-1591
CONTRACTOR: Southern Research Institute
PROJECT MONITOR: E. Ross (AFML/MXS)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: Thermal and mechanical properties of a three-dimensional carbon-carbon composite were generated at room and elevated temperatures. The properties were generated for use in the thermostructural analysis of reentry vehicle nosetips. Individual data points and curves are given and probable value curves based on the individual data are also presented.

REPORT NO: AFML-TR-74-234 AD B000 960L
ACCESS NO: 203,242 December 1974
TITLE: BIRD STRIKE CAPABILITIES OF TRANSPARENT AIRCRAFT WINDSHIELD MATERIALS
AUTHOR(S): A.O. Ingelse, E.L. Waters, G.E. Wintermute
CONTRACT NO: F33615-72-C-1896
CONTRACTOR: Goodyear Aerospace Corporation
PROJECT MONITOR: S. Marolo (AFML/MXE)
DIST. STATEMENT: U.S. Govt. Only
ABSTRACT: This report covers the program conducted to obtain materials response data on selected aircraft transparency materials and composites to assess their bird strike capabilities. The program was basically a two-phase program, with Phase I consisting of a thorough survey of existing bird strike data plus the design and testing of a universal specimen configuration, including brackets, definition of the test program, and test series to verify adequacy of the specimen mounting techniques. Phase II consisted of a detailed test program pluse compilation and presentation of the engineering data in a usable form.

REPORT NO: AFML-TR-74-261 AD A004 199
ACCESS NO: 203,260 December 1974
TITLE: FRACTURE RELATED PROPERTIES OF X-2048-T851 PLATE INCLUDING SPECIMEN SIZE EFFECTS ON $K_{IC}$
AUTHOR(S): G.J. Petrak
CONTRACT NO: F33615-74-C-5024
CONTRACTOR: University of Dayton Research Institute
PROJECT MONITOR: D. Watson (AFML/MXE)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: Mechanical property data were developed on a new aluminum alloy that is designated as X2048. The material, which was tested in the -T851 condition, was developed by its manufacturer, Reynolds Aluminum, to possess the strength, fatigue resistance, thermal stability,and corrosion

resistance of 2024-T851 and 2124-T851 while at the same time having increased toughness. It was shown that the strength and fatigue crack growth rate of X2048 are the same as 2024 and 2124 and that the X2048 possesses increased toughness. A limited corrosion study using precracked specimens showed the material to be unaffected by a salt water environment under the test conditions. The room temperature fracture test results were dependent on specimen size with larger specimens producing higher fracture toughness test data. Fracture toughness test data from the literature that was obtained using bend specimens were lower than the fracture toughness results obtained in this effort which employed compact tension specimens.

TECHNICAL SERVICES DIVISION (AFML/TU)

REPORT NO: AFML-TR-74-19, Volume I AD 779-679
ACCESS NO: 202,687 February 1974
TITLE: THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES. I. BROMOACETIC ACID AND SODIUM BROMOACETATE

AUTHOR(S): J.E. Katon, R.L. Kleinlein
CONTRACT NO: F33615-73-C-5013
CONTRACTOR: Miami University
PROJECT MONITOR: C. Houston (AFML/TUA)
PROJECT NO: 7360
TASK NO: 736005
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The complete vibrational spectra of solid bromoacetic acid ($CH_2BrCO_2H$) have been recorded along with most of the vibrational spectra of $CH_2BrCO_2D$, $CD_2BrCO_2D$ and $CD_2BrCO_2H$. These spectra have been assigned to approximate normal modes of vibration. In addition, the complete vibrational spectra of crystalline sodium bromoacetate and sodium bromoacetate-d2 have been recorded and a vibrational assignment proposed. The intermolecular coupling of these compounds is quite strong and the data is consistent with a centrosymmetric unit cell containing at least four molecules.

REPORT NO: AFML-TR-74-19, Volume II AD 785 359
ACCESS NO: 202,687 May 1974
TITLE: THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES. II. BENZOYL CHLORIDE, BENZOYL BROMIDE, AND METHYL CHLOROFORMATE

AUTHOR(S): J.E. Katon, D.A. Condit, M.G. Griffin
CONTRACT NO: F33615-73-C-5013
CONTRACTOR: Miami University
PROJECT MONITOR: C. Houston (AFML/TUA)
PROJECT NO: 7360
TASK NO: 736005
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: The infrared and Raman spectra of benzoyl chloride, benzoyl chloride-d and benzoyl bromide have been measured between 75-4000 $cm^{-1}$. Assignments for the fundamental modes of vibration are presented. In addition, the infrared spectra of methyl chloroformate and methyl chloroformate-d3 are reported in the liquid and solid phases in the region 4000-50 $cm^{-1}$. The liquid phase Raman spectra of these compounds is also reported. It is found that the two compounds readily crystallize as oriented polycrystalline films when cooled in contact with cesium iodide windows. The polarized infrared spectra obtained with these films makes possible an improved vibrational assignment for the light compound and a good first assignment for the deuterium substituted analogue. The results are most consistent with a planar cis structure and there is no indication of the existence of a second conformer. No clear cases of crystal splitting are observed.

AFML/TU

REPORT NO: AFML-TR-74-83 AD 784 922
ACCESS NO: 202,969 May 1974
TITLE: RESEARCH ON THE THERMOLYTIC DISSOCIATION OF MOLECULES
AUTHOR(S): W.R. Feairheller, M.D. Schumacher, W.D. Ross
CONTRACT NO: F33615-72-C-1611
CONTRACTOR: Monsanto Research Corp.
PROJECT MONITOR: F. Bentley, W. Ward, C. Houston (AFML/TUA)
PROJECT MONITOR: 7360
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: A pyrolysis-gas chromatographic system assembled at WPAFB and employed in the separations and identification of organic materials was provided with a data handling system to allow computer processing of the chromatographic results. In brief, the system separates a mixture into components and then pyrolyzes these components one at a time. The pyrolysis products are separated by two chromatographic systems and from their identity, the original compound can be identified. In this effort the data handling system was installed, checked out, and tested for reliability. The system provides the data in the form of a computer output giving the retention times, retention temperature, and peak area. This system provides reliable and reproducible data for identification of organic compounds of interest to the Air Force Materials Laboratory.

PLANS OFFICE (AFML/XR)

REPORT NO: AFML-TR-74-270 AD A005 386
ACCESS NO: 203,299 October 1974
TITLE: AIR FORCE TECHNICAL OBJECTIVE DOCUMENT
AUTHOR(S):
CONTRACT NO: internal
CONTRACTOR: N/A
PROJECT MONITOR: R. Adamczak (AFML/XR)
DIST. STATEMENT: Approved for public release; distribution unlimited.
ABSTRACT: This Technical Objective Document was prepared by the Air Force Materials Laboratory and describes the Materials Technology Areas for meeting future Air Force operational needs. The six Technology Areas encompass the full spectrum of materials capabilities required for future aircraft, missile, space, and electronic systems: Thermal Protection Materials; Aerospace Structural Materials; Aerospace Propulsion Materials; Fluid, Lubricant, and Elastomeric Materials; Protective Coatings and Materials; and Electromagnetic Materials. Presented for each TA is the general objective, specific goals, technical approaches, and a Laboratory TA focal point who can facilitate face-to-face discussions with Laboratory engineers and scientists.

## SUBJECT INDEX

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| ABLATIVE | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| ABSORBING | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM) | 201827/008 |
| ABSORPTION | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| ABSTRACTS | ABSTRACTS OF AF MATERIALS LABORATORY REPORTS JANUARY - DECEMBER 1973 | OR-182/001 |
| ABSTRACTS | ABSTRACTS OF ACTIVE CONTRACTS AIR FORCE MATERIALS LABORATORY | 202855/001 |
| ACID | HETEROCYCLIC POLYMERS DERIVED FROM 1,2,4,5-NAPHTHALENETETRACARBOXYLIC ACID DIANHYDRIDE | 202432/066 |
| ACID | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| ACIDS | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| ACIDS | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| ACOUSTIC | ACOUSTIC DELAY LINES | 202864/038 |
| ACOUSTIC | ALUMINUM NITRIDE FOR SURFACE ACOUSTIC WAVES | 203184/042 |
| ACOUSTIC | RESEARCH ON YB66 FOR MICROWAVE ACOUSTIC CRYSTALS | 203334/044 |

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| ACRYLIC | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| ACTIVE | ABSTRACTS OF ACTIVE CONTRACTS AIR FORCE MATERIALS LABORATORY | 202855/001 |
| ADDITION-CURED | DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES | 203166/090 |
| ADHESIVE | IMPROVED FATIGUE STRENGTH ADHESIVE | 203261/090 |
| ADHESIVE | DURABILITY OF ADHESIVE BONDED JOINTS | 201807/100 |
| ADHESIVE | DIELECTROMETER MONITORED ADHESIVE BONDING | 202649/074 |
| ADHESIVE | IMPROVED SURFACE TREATMENTS OF TITANIUM ALLOYS FOR ADHESIVE BONDING | 202461/070 |
| ADHESIVELY | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/060 |
| ADHESIVELY | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/085 |
| ADHESIVES | DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES | 203166/080 |
| AEDC | FRACTURE MECHANICS TESTS AND ANALYSIS OF THE AEDC APTU STORAGE VESSEL MATERIAL | 203346/104 |
| AF | ABSTRACTS OF AF MATERIALS LABORATORY REPORTS JANUARY - DECEMBER 1973 | OR-182/001 |
| AFFDL | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/104 |
| AF2-1DA | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |
| AGING | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| AGING | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| AGING | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |

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| AGSR | MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE | 203227/105 |
| AIDED | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| AIR | LIQUID CRYSTALS FOR AIR FORCE DISPLAYS | 203029/031 |
| AIR | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| AIR | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| AIR | ABSTRACTS OF ACTIVE CONTRACTS AIR FORCE MATERIALS LABORATORY | 202855/031 |
| AIR | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| AIR | STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS | 202925/088 |
| AIR | FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS | 203305/091 |
| AIR | AIR FORCE TECHNICAL OBJECTIVE DOCUMENT | 203299/110 |
| AIRBORNE | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| AIRCRAFT | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| AIRCRAFT | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| AIRCRAFT | COMPUTER AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS | 202509/011 |
| AIRCRAFT | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/005 |
| AIRCRAFT | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |

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| AIRCRAFT | FILAMENT WOUND 67-GALLON TANK FOR AQM-34M AIRCRAFT | 202995/103 |
| AIRCRAFT | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| AIRCRAFT | BIRD STRIKE CAPABILITIES OF TRANSPARENT AIRCRAFT WINDSHIELD MATERIALS | 203242/106 |
| ALKALI | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| ALKALI | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| ALLOWABLE | THE COLLECTION GENERATION AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA | 202870/102 |
| ALLOWABLES | INCREASING DESIGN ALLOWABLES FOR A GRAPHITE | 202537/098 |
| ALPHA-BETA | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| ALTERNATE | ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE | 202886/075 |
| ALUMINUM | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| ALUMINUM | ALUMINUM NITRIDE FOR SURFACE ACOUSTIC WAVES | 203184/042 |
| ALUMINUM | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| ALUMINUM | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |
| ALUMINUM | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| ALUMINUM | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |

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| ALUMINUM | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| ALUMINUM | MANUFACTURING PROCESSES FOR 20MM (M103) ALUMINUM ALLOY CARTRIDGE CASES | 201539/045 |
| ALUMINUM | FABRICATION PROCESS FOR ALUMINUM COMPOSITES | 200990/061 |
| ALUMINUM | ENGINEERING DESIGN DATA FOR ALUMINUM ALLOY 2124-T851 THICK PLATE | 202556/099 |
| ALUMINUM | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/069 |
| ANALYTICAL | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| ANALYTICAL | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| ANISOTROPIC | EXPLORATORY DEVELOPMENT ON BASIC FAILURE BEHAVIOR OF ANISOTROPIC POLYMERIC MATERIAL | 203125/080 |
| ANNEALED | MECHANICAL PROPERTIES OF TI-6AL-4V ANNEALED FORGINGS V | 202682/101 |
| ANTENNAS | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| APP | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| APPLICATION | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| APPLICATION | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| APPLICATION | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| APPLICATION | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |

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| APPLICATION | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/059 |
| APPLICATIONS | II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS | 202697/034 |
| APPLICATIONS | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| APPLICATIONS | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| APPLICATIONS | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |
| APPLICATIONS | FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS | 203305/091 |
| APTU | FRACTURE MECHANICS TESTS AND ANALYSIS OF THE AEDC APTU STORAGE VESSEL MATERIAL | 203346/104 |
| AQM-34M | FILAMENT WOUND 67-GALLON TANK FOR AQM-34M AIRCRAFT | 202995/103 |
| ARC | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/086 |
| AREA | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |
| AREA | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| ARRAY | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| ASSESS | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/077 |
| ASSESSMENT | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| ASSESSMENT | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT I (APPENDIX A) MATERIALS CHARACTERIZATION | 203222/100 |

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| ASSESSMENT | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT 5 (APPENDIX E) FAILURE ANALYSIS | 203222/101 |
| ASSESSMENT | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/095 |
| ASSESSMENT | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/067 |
| ATJS | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/104 |
| ATJS | IMPROVED ATJS GRAPHITE PART I. MATERIALS AND PROCESS STUDIES | 203347/071 |
| ATTACHMENT | ADVANCED COMPOSITE WING AND EMPENNAGE TO FUSELAGE ATTACHMENT | 300167/004 |
| ATTRITION | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| AUTOMATED | COMPUTER AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS | 202509/011 |
| AUTOMATED | IMPROVED AUTOMATED TAPE LAYING MACHINE | 200397/046 |
| AUTOMATION | AUTOMATION OF COATING PROCESSES FOR GAS TURBINE BLADES AND VANES | 069987/047 |
| BALL | PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS | 203079/092 |
| BALLISTIC | DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER | 203202/100 |
| BAY | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| BEAM | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| BEAM | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |

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| BEARINGS | PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS | 203079/092 |
| BENZIMIDAZOISOQ | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS | 300132/069 |
| BENZOYL | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| BENZOYL | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| BERYLLIUM | BIAXIAL STRENGTH TESTS ON BERYLLIUM AND TITANIUM ALLOYS | 203185/025 |
| BERYLLIUM | MANUFACTURE OF BERYLLIUM STRUCTURES | 202542/045 |
| BIAXIAL | BIAXIAL STRENGTH TESTS ON BERYLLIUM AND TITANIUM ALLOYS | 203185/025 |
| BIBENZOXAZOLE | FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS | 203157/079 |
| BIMATRIX | BIMATRIX ABLATIVE COMPOSITES. PART I: EVALUATION OF MATERIALS CONCEPTS | 203210/085 |
| BIRD | BIRD STRIKE CAPABILITIES OF TRANSPARENT AIRCRAFT WINDSHIELD MATERIALS | 203242/106 |
| BLADE | HIGH STRENGTH TURBINE BLADE DOVETAILS | 201116/059 |
| BLADES | AUTOMATION OF COATING PROCESSES FOR GAS TURBINE BLADES AND VANES | 069987/047 |
| BLADES | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| BONDED | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/050 |
| BONDED | DURABILITY OF ADHESIVE BONDED JOINTS | 201807/100 |
| BONDED | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/095 |

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| BONDING | ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES | 203220/027 |
| BONDING | DIELECTROMETER MONITORED ADHESIVE BONDING | 202649/074 |
| BONDING | IMPROVED SURFACE TREATMENTS OF TITANIUM ALLOYS FOR ADHESIVE BONDING | 202461/070 |
| BOOT | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| BORON | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |
| BORON | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| BORON | MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES | 203306/094 |
| BORON | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| BORON-ALUMINUM | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| BORON/ALUMINUM | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| BORON/ALUMINUM | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |
| BOUNDARY | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |
| BOX | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| BOX | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |
| BRITTLE | ANALYSIS OF MULTIPLE PARTICLE IMPACTS ON BRITTLE MATERIALS | 203204/096 |

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| BROAD | BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS | 203302/091 |
| BROMIDE | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| BROMOACETATE | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| BROMOACETIC | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| BUBBLE | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| BUBBLE | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| BULKHEADS | ISOTHERMAL FORGING OF TITANIUM ALLOY BULKHEADS | 069612/058 |
| CADMIUM | METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE | 202657/035 |
| CALIBRATION | CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER | 202874/075 |
| CALORIMETER | DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER | 203202/100 |
| CAMERA | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES | 200375/056 |
| CAMERA | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES VOL II | 200375/057 |
| CAMOUFLAGE | INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS | 203216/095 |
| CANDIDATE | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/048 |
| CAPABILITIES | BIRD STRIKE CAPABILITIES OF TRANSPARENT AIRCRAFT WINDSHIELD MATERIALS | 203242/106 |

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| CARBON | PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE | 201731/058 |
| CARBON | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED, SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| CARBON | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| CARBONITRIDE | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202981/039 |
| CARBON-CARBON | THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS | 202570/098 |
| CARBON-CARBON | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT 5 (APPENDIX E) FAILURE ANALYSIS | 203222/101 |
| CARBON-CARBON | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT I (APPENDIX A) MATERIALS CHARACTERIZATION | 203222/100 |
| CARBON-CARBON | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| CARTRIDGE | MANUFACTURING PROCESSES FOR 20MM (M103) ALUMINUM ALLOY CARTRIDGE CASES | 201539/045 |
| CASTING | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |
| CASTINGS | PROCESS FOR HIGH INTEGRITY CASTINGS | 201117/059 |
| CC | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/104 |
| CELLULAR | GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT | 203206/012 |
| CHARACTERISTICS | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| CHARACTERISTICS | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203197/022 |

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| CHARACTERIZATIO | LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGH POWER IR LASERS | 201824/030 |
| CHARACTERIZATIO | RESEARCH AND DEVELOPMENT ON CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS | 202790/035 |
| CHARACTERIZATIO | SYNTHESIS AND CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS | 203208/043 |
| CHARACTERIZATIO | MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE | 203227/105 |
| CHARACTERIZATIO | DEVELOPMENT AND CHARACTERIZATION OF MATERIALS RESISTANT TO SUPERSONIC EROSION | 203122/087 |
| CHARACTERIZATIO | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/096 |
| CHARACTERIZATIO | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| CHARACTERIZATIO | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT I (APPENDIX A) MATERIALS CHARACTERIZATION | 203222/100 |
| CHLORIDE | MERCUROUS CHLORIDE POLARIZER MATERIAL | 203055/037 |
| CHLORIDE | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| CHLORIDE | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| CHLOROFORMATE | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| CIRCUIT | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM) | 201827/018 |
| CLEAVED | METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE | 202657/035 |

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| CLOTHING | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/083 |
| COATED | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| COATED | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/091 |
| COATING | AUTOMATION OF COATING PROCESSES FOR GAS TURBINE BLADES AND VANES | 069987/047 |
| COATING | HIGH TEMPERATURE POLYMERIC COATING MATERIALS | 203123/099 |
| COATING | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/083 |
| COATINGS | WEAR AND FRETTING FATIGUE RESISTANT COATINGS FOR TITANIUM ALLOYS | 202597/016 |
| COATINGS | WATER-BASE COATINGS | 203416/095 |
| COATINGS | INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS | 203216/095 |
| COATINGS | EVALUATION OF ELASTOMERS PLASTICS COATINGS AND METALS | 202985/103 |
| COATINGS | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| COATINGS | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| COBALT | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202958/038 |
| COBALT | RARE EARTH COBALT SINGLE CRYSTALS | 202654/034 |
| COBALT | MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS | 202426/033 |
| COBALT | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| COBALT | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |

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| COBALT-BASE | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| COERCIVITY | RCO5 COERCIVITY | 203191/041 |
| COLDWORKED | STRESS ANALYSIS OF COLDWORKED FASTENER HOLES | 202926/019 |
| COLDWORKING | SLEEVE COLDWORKING FASTENER HOLES VOLUME I DISCUSSION AND SUMMARY | 201121/049 |
| COLLECTION | THE COLLECTION GENERATION AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA | 202870/102 |
| COLUMBIUM | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| COMPACT | PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS | 203079/092 |
| COMPACTS | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| COMPLEX | A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS | 203181/093 |
| COMPOSED | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/104 |
| COMPOSITE | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| COMPOSITE | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |
| COMPOSITE | COMPOSITE STRUCTURE SAFELIFE PREDICTION | 069543/003 |
| COMPOSITE | INTERACTIVE PROGRAM IN DESIGN AND ANALYSIS OF COMPOSITE MATERIALS | 202863/003 |
| COMPOSITE | ADVANCED COMPOSITE WING AND EMPENNAGE TO FUSELAGE ATTACHMENT | 300167/004 |
| COMPOSITE | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/005 |

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| COMPOSITE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 300282/005 |
| COMPOSITE | COMPOSITE ENGINE CONCEPTUAL DESIGN | 202991/006 |
| COMPOSITE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 203024/006 |
| COMPOSITE | PRODUCTION PROCESSES FOR COMPOSITE TAPES | 200395/048 |
| COMPOSITE | MANUFACTURING METHODS FOR DIMENSIONALLY STABLE COMPOSITE MICROWAVE COMPONENTS | 201739/053 |
| COMPOSITE | MANUFACTURING METHODS FOR ADVANCED COMPOSITE HONEYCOMB | 201115/056 |
| COMPOSITE | A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS | 203181/093 |
| COMPOSITE | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/091 |
| COMPOSITE | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| COMPOSITE | EXPLORATORY DEVELOPMENT ON FRACTURE MECHANICS OF COMPOSITE MATERIALS | 203120/093 |
| COMPOSITE | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/084 |
| COMPOSITES | ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES | 203220/027 |
| COMPOSITES | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |
| COMPOSITES | FAILURE PROCESSES IN METAL MATRIX COMPOSITES | 202558/016 |
| COMPOSITES | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| COMPOSITES | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| COMPOSITES | MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES | 202631/020 |

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| COMPOSITES | GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT | 203206/012 |
| COMPOSITES | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| COMPOSITES | MANUFACTURING PROCESS FOR LUBRICATING COMPOSITES | 200231/052 |
| COMPOSITES | STRUCTURAL FABRICATION GUIDE FOR ADVANCED COMPOSITES | 200654/054 |
| COMPOSITES | FABRICATION PROCESS FOR ALUMINUM COMPOSITES | 200990/061 |
| COMPOSITES | MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES | 203306/094 |
| COMPOSITES | BIMATRIX ABLATIVE COMPOSITES. PART I: EVALUATION OF MATERIALS CONCEPTS | 203210/085 |
| COMPOSITES | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| COMPOSITES | FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES | 203167/090 |
| COMPOSITES | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| COMPOSITES | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| COMPOSITION | RELATIONSHIP OF COMPOSITION AND STRUCTURE TO STRENGTH IN TITANIUM ALLOYS | 202853/008 |
| COMPUTER | COMPUTER AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS | 202509/011 |
| COMPUTER | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| CONICAL | LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES | 202595/013 |
| CONICAL | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| CONSTRAINED | CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER | 203005/015 |

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| CONTACTS | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| CONTINUOUS | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| CONTROL | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| CONTROL | CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER | 203005/015 |
| CONTROL | IMPROVEMENT OF TITANIUM ALLOY INGOTS BY SOLIDIFICATION CONTROL | 069473/051 |
| CONTROL | CORROSION CONTROL AT GRAPHITE/EPOXY-ALUMINUM AND TITANIUM INTERFACES | 203211/088 |
| CONVERGING | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| CONVERGING | LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES | 202595/013 |
| CORROSION | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| CORROSION | CORROSION CONTROL AT GRAPHITE/EPOXY-ALUMINUM AND TITANIUM INTERFACES | 203211/088 |
| COST | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |
| COS/MOS | MANUFACTURING METHODS FOR COS/MOS MEMORY | 203108/050 |
| CRACK | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| CRACK | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| CRACK | A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT | 203041/021 |
| CRACKS | DETECTION OF CRACKS UNDER INSTALLED FASTENERS | 203212/021 |

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| CRITERION | FRACTURE CRITERION FOR MATERIALS IN PLASTIC DEFORMATION PROCESSES | 203149/024 |
| CROSS-SECTIONAL | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |
| CRYSTAL | ND-DOPED MIXED CRYSTAL LASER MATERIAL RESEARCH | 202890/040 |
| CRYSTAL | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| CRYSTAL | MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES | 203047/060 |
| CRYSTALS | LIQUID CRYSTALS FOR AIR FORCE DISPLAYS | 203029/031 |
| CRYSTALS | RARE EARTH COBALT SINGLE CRYSTALS | 202654/034 |
| CRYSTALS | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| CRYSTALS | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXC05 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| CRYSTALS | RESEARCH ON YB66 FOR MICROWAVE ACOUSTIC CRYSTALS | 203334/044 |
| CURE | DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM | 203153/046 |
| CYCLIC | AN EVALUATION OF THE EFFECTS OF CYCLIC LOADING ON THE STRENGTH OF ZINC SELENIDE | 203300/022 |
| DAMAGE | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| DEFINITION | PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION | 203265/028 |
| DEFORMATION | FRACTURE CRITERION FOR MATERIALS IN PLASTIC DEFORMATION PROCESSES | 203149/024 |
| DEFORMATION | PROJECT THEMIS:METAL DEFORMATION PROCESSING | 202701/019 |
| DEGRADATION | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/067 |

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| DEHYDRIDING | DEHYDRIDING OF TITANIUM ALLOY (TI-6246) HYDRIDED POWDER | 202856/018 |
| DELAY | ACOUSTIC DELAY LINES | 202864/038 |
| DEPOSITION | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |
| DEPOSITION | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| DERIVATIVES | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| DERIVATIVES | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| DESIGN | INTERACTIVE PROGRAM IN DESIGN AND ANALYSIS OF COMPOSITE MATERIALS | 202863/003 |
| DESIGN | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 300282/005 |
| DESIGN | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |
| DESIGN | COMPOSITE ENGINE CONCEPTUAL DESIGN | 202991/006 |
| DESIGN | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 203024/006 |
| DESIGN | INCREASING DESIGN ALLOWABLES FOR A GRAPHITE | 202537/098 |
| DESIGN | THE COLLECTION GENERATION AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA | 202870/102 |
| DESIGN | ENGINEERING DESIGN DATA FOR ALUMINUM ALLOY 2124-T851 THICK PLATE | 202556/099 |
| DETECTION | DETECTION OF CRACKS UNDER INSTALLED FASTENERS | 203212/021 |
| DEWETTING | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/067 |

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| DIAMETER | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202981/039 |
| DIAMETER | PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE | 201731/058 |
| DIANHYDRIDE | HETEROCYCLIC POLYMERS DERIVED FROM 1,2,4,5-NAPHTHALENETETRACARBOXYLIC ACID DIANHYDRIDE | 202432/066 |
| DIBEZOTHIOPHENE | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS | 300132/069 |
| DIELECTROMETER | DIELECTROMETER MONITORED ADHESIVE BONDING | 202649/074 |
| DIES | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| DIES | LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES | 202595/013 |
| DIFFRACTION | MAGNETIC NEUTRON DIFFRACTION STUDIES OF PRCO5 AND SMCO5 | 202430/031 |
| DIFFUSE | INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS | 203216/095 |
| DIFFUSION | ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES | 203220/027 |
| DIRECTIONALLY | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| DISCUSSION | SLEEVE COLDWORKING FASTENER HOLES VOLUME I DISCUSSION AND SUMMARY | 201121/049 |
| DISK | DEVELOPMENT OF A VERY HIGH STRENGTH DISK ALLOY FOR 1400F SERVICE | 203186/026 |
| DISPERSION | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| DISPERSION | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |

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| DISPLACEMENT | A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT | 203041/021 |
| DISPLAY | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| DISPLAYS | LIQUID CRYSTALS FOR AIR FORCE DISPLAYS | 203029/031 |
| DISSOCIATION | RESEARCH ON THE THERMOLYTIC DISSOCIATION OF MOLECULES | 202969/109 |
| DOCUMENT | AIR FORCE TECHNICAL OBJECTIVE DOCUMENT | 203299/110 |
| DOMAIN | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| DOMAIN | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| DOVETAILS | HIGH STRENGTH TURBINE BLADE DOVETAILS | 201116/059 |
| DRESS | FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS | 203305/091 |
| DRY | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| DUCTILITY | FORMULATION OF THE LIMITING DUCTILITY IN METALWORKING PROCESSES | 203182/025 |
| DURABILITY | DURABILITY OF ADHESIVE BONDED JOINTS | 201807/100 |
| DYED | DEVELOPMENT OF THERMALLY STABLE DYED FABRIC | 300297/065 |
| DYNAMIC | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| DYNAMIC | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| DYNAMIC | STATIC AND DYNAMIC INTERPRETATION OF TITANIUM ALLOY PHOTOMICROGRAPH FEATURES | 203335/027 |
| EARTH | MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS | 202426/033 |

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| EARTH | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |
| EARTH | RARE EARTH COBALT SINGLE CRYSTALS | 202654/034 |
| EARTH | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |
| ECONOMICA_ | DEVELOPMENT OF ECONOMICAL SHEET TITANIUM ALLOY | 200960/014 |
| EFFICIENCY | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| ELASTIC | MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES | 202631/020 |
| ELASTICITY | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/034 |
| ELASTOHYDRODYNA | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| ELASTOMERIC | NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS | 202928/082 |
| ELASTOMERS | EVALUATION OF ELASTOMERS PLASTICS COATINGS AND METALS | 202985/103 |
| ELASTOMERS | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE TRIAZINE ELASTOMERS | 202506/071 |
| ELECTROMAGNETIC | RESEARCH AND DEVELOPMENT ON CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS | 202790/035 |
| ELECTROMAGNETIC | SYNTHESIS AND CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS | 203208/043 |
| ELECTRON | INELASTIC ELECTRON SPECTROSCOPY STUDY | 202694/076 |
| ELLIPSOMETRY | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/069 |
| EMPENNAGE | ADVANCED COMPOSITE WING AND EMPENNAGE TO FUSELAGE ATTACHMENT | 300167/004 |

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| EMPLOYED | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| ENERGY | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| ENGINE | COMPOSITE ENGINE CONCEPTUAL DESIGN | 202991/006 |
| ENGINE | MANUFACTURING METHODS FOR PRODUCTION OF QUALITY SUPERALLOY ENGINE PARTS | 201738/063 |
| ENGINE | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |
| ENGINE | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| ENVIRONMENT | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |
| ENVIRONMENT | EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS | 079616/064 |
| ENVIRONMENTAL | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| ENVIRONMENTS | THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS | 202570/098 |
| EQUILIBRIA | STUDY OF PHASE EQUILIBRIA IN THE SYSTEM T1-AS-S AND T1-AS-SE | 202460/033 |
| EROSION | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/031 |
| EROSION | DEVELOPMENT AND CHARACTERIZATION OF MATERIALS RESISTANT TO SUPERSONIC EROSION | 203122/097 |
| EROSION | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| EROSION | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |

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| EROSION | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| EROSIVE | EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS | 079616/064 |
| ETHER | FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS | 203157/079 |
| EXP | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| EXPERIMENTAL | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/085 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM) | 201827/008 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT ON LASER AND OPTICAL MATERIALS | 203329/044 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF POLYUREYLENE/ACYLSEMICARBAZIDE RESINS | 203304/092 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT ON FRACTURE MECHANICS OF COMPOSITE MATERIALS | 203120/093 |

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| EXPLORATORY | EXPLORATORY DEVELOPMENT OF NEW AND IMPROVED SELF-SEALING MATERIALS FOR FUEL LINES | 203214/082 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. | 202596/068 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/068 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS | 203188/078 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT ON BASIC FAILURE BEHAVIOR OF ANISOTROPIC POLYMERIC MATERIAL | 203125/080 |
| EXPLORATORY | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE TRIAZINE ELASTOMERS | 202506/071 |
| EXPOSED | LABORATORY TEST TECHNIQUES FOR EVALUATING THE THERMAL PROTECTION OF MATERIALS WHEN EXPOSED TO VARIOUS HEAT SOURCES | 202918/085 |
| EXTENDED | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| EXTRUSION | HYDROSTATIC EXTRUSION OF TITANIUM ALLOY TUBING | 069791/054 |
| FABRIC | DEVELOPMENT OF THERMALLY STABLE DYED FABRIC | 300297/065 |
| FABRIC | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| FABRICATION | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| FABRICATION | FABRICATION PROCESS FOR ALUMINUM COMPOSITES | 200990/061 |
| FABRICATION | FABRICATION TECHNIQUES FOR RIVET FASTENERS UTILIZING 55-NITINOL | 202858/048 |
| FABRICATION | STRUCTURAL FABRICATION GUIDE FOR ADVANCED COMPOSITES | 200654/054 |

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| FABRICS | FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS | 203305/091 |
| FACES | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| FAILURE | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| FAILURE | FAILURE PROCESSES IN METAL MATRIX COMPOSITES | 202558/016 |
| FAILURE | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |
| FAILURE | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| FAILURE | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT 5 (APPENDIX E) FAILURE ANALYSIS | 203222/101 |
| FAILURE | EXPLORATORY DEVELOPMENT ON BASIC FAILURE BEHAVIOR OF ANISOTROPIC POLYMERIC MATERIAL | 203125/080 |
| FAILURE | ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE | 202886/075 |
| FAILURE | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| FAN | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| FASTENER | STRESS INTENSITY FACTORS FOR SOME THRU-CRACKED FASTENER HOLES | 202971/020 |
| FASTENER | STRESS ANALYSIS OF COLDWORKED FASTENER HOLES | 202926/019 |
| FASTENER | SLEEVE COLDWORKING FASTENER HOLES VOLUME I DISCUSSION AND SUMMARY | 201121/049 |
| FASTENER | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| FASTENERS | DETECTION OF CRACKS UNDER INSTALLED FASTENERS | 203212/021 |
| FASTENERS | FABRICATION TECHNIQUES FOR RIVET FASTENERS UTILIZING 55-NITINOL | 202658/048 |

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| FATIGUE | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| FATIGUE | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/014 |
| FATIGUE | WEAR AND FRETTING FATIGUE RESISTANT COATINGS FOR TITANIUM ALLOYS | 202597/016 |
| FATIGUE | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| FATIGUE | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| FATIGUE | IMPROVED FATIGUE STRENGTH ADHESIVE | 203261/090 |
| FCC | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| FEATURES | STATIC AND DYNAMIC INTERPRETATION OF TITANIUM ALLOY PHOTOMICROGRAPH FEATURES | 203335/027 |
| FERRITES | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| FIBER | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/091 |
| FIBER | FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES | 203167/090 |
| FIBER | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| FIBERS | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDES THE STRESS SUPERCONDUCTING FIBERS | 202981/039 |
| FIBERS | HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS | 202573/075 |
| FIBER-REINFORCE | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/094 |

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| FIBROUS | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| FIBROUS | EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS | 203188/078 |
| FIGHTER'S | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/093 |
| FILAMENT | PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE | 201731/058 |
| FILAMENT | FILAMENT WOUND 67-GALLON TANK FOR AQM-34M AIRCRAFT | 202995/103 |
| FILAMENT | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| FILAMENTARY | MANUFACTURING METHODS FOR FILAMENTARY REINFORCED TITANIUM MONOTAPES | 200232/049 |
| FILAMENTS | SAPPHIRE FILAMENTS | 202868/077 |
| FILM | THIN FILM GARNET MANUFACTURING METHODS | 202915/059 |
| FILM | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| FILM | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| FILM | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/059 |
| FILMS | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| FIRE | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| FIRE | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/093 |

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| FIT | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| FITTING | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/060 |
| FLASH | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| FLAW | PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION | 203265/028 |
| FLIGHT | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/005 |
| FLIGHT-BY-FLIGH | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| FLOAT | CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER | 202874/075 |
| FLOW | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| FLOW | LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES | 202595/013 |
| FLUORINATION | SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION | 200984/070 |
| FLUORINE-19/ | FLUORINE-19 NUCLEAR MAGNETIC RESONANCE | 202865/036 |
| FLUOROCARBON | FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS | 203157/079 |
| FLUOROCARBON | SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION | 200984/070 |
| FLUOROELASTOMER | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| FLUOROELASTOMER | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |

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| FLUOROELASTOMER | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| FLUX | THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS | 202570/038 |
| FORCE | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| FORCE | LIQUID CRYSTALS FOR AIR FORCE DISPLAYS | 203029/031 |
| FORCE | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| FORCE | ABSTRACTS OF ACTIVE CONTRACTS AIR FORCE MATERIALS LABORATORY | 202855/011 |
| FORCE | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| FORCE | STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS | 202925/088 |
| FORCE | FABRICS FOR AIR FORCE DRESS UNIFORM APPLICATIONS | 203305/091 |
| FORCE | AIR FORCE TECHNICAL OBJECTIVE DOCUMENT | 203299/110 |
| FORGING | ISOTHERMAL FORGING OF TITANIUM ALLOY BULKHEADS | 069612/058 |
| FORGING | ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS | 069421/057 |
| FORGINGS | COMPUTER AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS | 202509/011 |
| FORGINGS | IMPROVED MANUFACTURING METHODS FOR PRODUCING HIGH INTEGRITY MORE RELIABLE TITANIUM FORGINGS | 200233/046 |
| FORGINGS | ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS | 069421/057 |
| FORGINGS | MECHANICAL PROPERTIES OF TI-6AL-4V ANNEALED FORGINGS V | 202682/101 |
| FORMATION | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |

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| FORMING | FORMING TITANIUM ALLOY STRINGER SECTIONS UNDER HYDROSTATIC PRESSURE | 068209/055 |
| FORMING | PEEN FORMING TITANIUM PANELS | 090559/050 |
| FORMING | RENE' 95 (AF-95) SHEAR SPIN FORMING TECHNIQUES | 203235/062 |
| FORMULATION | FORMULATION OF THE LIMITING DUCTILITY IN METALWORKING PROCESSES | 203182/025 |
| FRACTURE | FRACTURE CRITERION FOR MATERIALS IN PLASTIC DEFORMATION PROCESSES | 203149/024 |
| FRACTURE | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| FRACTURE | FRACTURE MECHANICS TESTS AND ANALYSIS OF THE AEDC APTU STORAGE VESSEL MATERIAL | 203346/104 |
| FRACTURE | FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES | 203167/090 |
| FRACTURE | EXPLORATORY DEVELOPMENT ON FRACTURE MECHANICS OF COMPOSITE MATERIALS | 203120/083 |
| FRACTURE | FRACTURE RELATED PROPERTIES OF X-2048-T851 PLATE INCLUDING SPECIMEN SIZE EFFECTS ON KIC | 203260/106 |
| FRETTING | WEAR AND FRETTING FATIGUE RESISTANT COATINGS FOR TITANIUM ALLOYS | 202597/016 |
| FRICTION | THE ANALYTICAL DETERMINATION OF FRICTION FOR FLOW THROUGH CONICAL CONVERGING DIES | 202686/017 |
| FUEL | EXPLORATORY DEVELOPMENT OF NEW AND IMPROVED SELF-SEALING MATERIALS FOR FUEL LINES | 203214/082 |
| FUNDAMENTAL | FUNDAMENTAL STUDIES ON REACTIVE OLIGOMERS | 203190/079 |
| FURNACE | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/096 |
| FUSELAGE | ADVANCED COMPOSITE WING AND EMPENNAGE TO FUSELAGE ATTACHMENT | 300167/004 |
| FUSELAGE | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/060 |
| F-104 | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/060 |

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| GAP | NARROW GAP SEMICONDUCTORS --PBSNTE AND PBSNSE | 203350/041 |
| GARMENTS | STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS | 202925/088 |
| GARNET | MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES | 203047/060 |
| GARNET | THIN FILM GARNET MANUFACTURING METHODS | 202915/059 |
| GAS | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| GAS | AUTOMATION OF COATING PROCESSES FOR GAS TURBINE BLADES AND VANES | 069987/047 |
| GAS | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| GENERATION | THE COLLECTION GENERATION AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA | 202870/102 |
| GRAIN | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| GRAIN | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |
| GRAIN | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| GRAPHICAL | ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE | 202886/075 |
| GRAPHICS | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| GRAPHITE | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |
| GRAPHITE | IMPROVED GRAPHITE REINFORCED TAPE | 201821/053 |
| GRAPHITE | MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE | 203227/105 |

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| GRAPHITE | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/104 |
| GRAPHITE | MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES | 203306/094 |
| GRAPHITE | FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES | 203167/090 |
| GRAPHITE | INCREASING DESIGN ALLOWABLES FOR A GRAPHITE | 202537/098 |
| GRAPHITE | IMPROVED ATJS GRAPHITE PART I. MATERIALS AND PROCESS STUDIES | 203347/071 |
| GRAPHITE | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| GRAPHITE/EPOXY- | CORROSION CONTROL AT GRAPHITE/EPOXY-ALUMINUM AND TITANIUM INTERFACES | 203211/086 |
| GROWTH | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| GROWTH | GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT | 203206/012 |
| GROWTH | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| GROWTH | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/069 |
| GUIDE | STRUCTURAL FABRICATION GUIDE FOR ADVANCED COMPOSITES | 200654/054 |
| HALIDES | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| HALIDES | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| HARDNESS | FRACTURE TOUGHNESS AGING BEHAVIOR GRAIN GROWTH AND HARDNESS OF ALPHA-BETA TITANIUM ALLOYS | 202433/009 |
| HARDWARE | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |

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| HAVING | HIGH TEMPERATURE RESINS HAVING IMPROVED PROCESSABILITY | 301195/081 |
| HEAT | HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER | 202986/097 |
| HEAT | DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER | 203202/100 |
| HEAT | EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS | 203188/078 |
| HEAT | LABORATORY TEST TECHNIQUES FOR EVALUATING THE THERMAL PROTECTION OF MATERIALS WHEN EXPOSED TO VARIOUS HEAT SOURCES | 202918/085 |
| HEATING | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| HEAT-RESISTANT | THE DEVELOPMENT OF HEAT-RESISTANT TITANIUM ALLOYS | 202666/014 |
| HELICOPTER | CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER | 203005/015 |
| HETEROCYCLIC | HETEROCYCLIC POLYMERS DERIVED FROM 1,2,4,5-NAPHTHALENETETRACARBOXYLIC ACID DIANHYDRIDE | 202432/066 |
| HETEROSTRUCTURE | II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS | 202697/034 |
| HIGH-HEAT | THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS | 202570/038 |
| HIGH-STRENGTH | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| HIGH-STRENGTH | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| HIGH-TEMPERATUR | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |

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| HISTORY | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| HOLES | STRESS ANALYSIS OF COLDWORKED FASTENER HOLES | 202926/019 |
| HOLES | STRESS INTENSITY FACTORS FOR SOME THRU-CRACKED FASTENER HOLES | 202971/020 |
| HOLES | SLEEVE COLDWORKING FASTENER HOLES VOLUME I DISCUSSION AND SUMMARY | 201121/049 |
| HOLOGRAPHIC | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURES INSPECTION | 203298/024 |
| HOLOGRAPHIC | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURE INSPECTION | 202429/010 |
| HONEYCOMB | MANUFACTURING METHODS FOR ADVANCED COMPOSITE HONEYCOMB | 201115/056 |
| HOT | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| HYDRAULIC | EVALUATION OF SHEAR-SPUN TI-3AL-2 5V TITANIUM ALLOY HYDRAULIC TUBING | 202857/102 |
| HYDRAULIC | EVALUATION OF TI-3AL-2 5V TITANIUM ALLOY HYDRAULIC TUBING | 202593/102 |
| HYDRAULIC | BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS | 203302/091 |
| HYDRIDED | DEHYDRIDING OF TITANIUM ALLOY (TI-6246) HYDRIDED POWDER | 202856/018 |
| HYDROGEN | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| HYDROSTATIC | FORMING TITANIUM ALLOY STRINGER SECTIONS UNDER HYDROSTATIC PRESSURE | 068209/055 |
| HYDROSTATIC | HYDROSTATIC EXTRUSION OF TITANIUM ALLOY TUBING | 069791/054 |
| HYPERSONIC | HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER | 202986/097 |

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| I | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| I | BIMATRIX ABLATIVE COMPOSITES. PART I: EVALUATION OF MATERIALS CONCEPTS | 203210/085 |
| III-V | II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS | 202697/034 |
| II-VI | II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS | 202697/034 |
| IMAGING | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/096 |
| IMPACT | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| IMPACT | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |
| IMPACT | MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES | 203306/094 |
| IMPACTS | ANALYSIS OF MULTIPLE PARTICLE IMPACTS ON BRITTLE MATERIALS | 203204/096 |
| IMPLEMENTATION | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |
| INELASTIC | INELASTIC ELECTRON SPECTROSCOPY STUDY | 202694/076 |
| INFRARED | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| INFRARED | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| INFRARED | INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS | 203216/095 |
| INFRARED | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/083 |

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| INGOTS | IMPROVEMENT OF TITANIUM ALLOY INGOTS BY SOLIDIFICATION CONTROL | 069473/051 |
| INSPECTION | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURES INSPECTION | 203298/024 |
| INSPECTION | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |
| INSPECTION | COMPUTER AUTOMATED ULTRASONIC INSPECTION SYSTEM FOR AIRCRAFT FORGINGS | 202509/011 |
| INSPECTION | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURE INSPECTION | 202429/010 |
| INSTALLED | DETECTION OF CRACKS UNDER INSTALLED FASTENERS | 203212/021 |
| INSULATOR | IMPROVED INSULATOR MATERIALS REQUIREMENT PROGRAM | 203389/105 |
| INTEGRITY | IMPROVED MANUFACTURING METHODS FOR PRODUCING HIGH INTEGRITY MORE RELIABLE TITANIUM FORGINGS | 200233/046 |
| INTEGRITY | SURFACE INTEGRITY OF MACHINED MATERIALS | 202760/052 |
| INTEGRITY | PROCESS FOR HIGH INTEGRITY CASTINGS | 201117/059 |
| INTENSITY | STRESS INTENSITY FACTORS FOR SOME THRU-CRACKED FASTENER HOLES | 202971/020 |
| INTENSITY | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| INTERACTIVE | INTERACTIVE PROGRAM IN DESIGN AND ANALYSIS OF COMPOSITE MATERIALS | 202863/093 |
| INTERDISCIPLINA | PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION | 203265/028 |
| INTERFACES | CORROSION CONTROL AT GRAPHITE/EPOXY-ALUMINUM AND TITANIUM INTERFACES | 203211/088 |
| INTERFERENCE | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| INTERFEROMETRIC | A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT | 203041/021 |

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| INVESTIGATE | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| INVOLVED | INVESTIGATION OF PARAMETERS INVOLVED IN METAL PROCESSING OPERATIONS | 202538/013 |
| IR | LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGH POWER IR LASERS | 201824/030 |
| IR | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| ISOTHERMAL | ISOTHERMAL FORGING OF TITANIUM ALLOY BULKHEADS | 069612/058 |
| ISOTHERMAL | ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS | 069421/057 |
| ISOTHERMAL | ISOTHERMAL SHAPE ROLLING OF TITANIUM AND SUPERALLOYS | 203083/052 |
| JANUARY | ABSTRACTS OF AF MATERIALS LABORATORY REPORTS JANUARY - DECEMBER 1973 | OR-182/001 |
| JOINTS | DURABILITY OF ADHESIVE BONDED JOINTS | 201807/100 |
| JOINTS | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/035 |
| JUNCTIONS | METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE | 202657/035 |
| KEVLAR | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS | 203342/079 |
| KIC | FRACTURE RELATED PROPERTIES OF X-2048-T851 PLATE INCLUDING SPECIMEN SIZE EFFECTS ON KIC | 203260/106 |
| KINETICS | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |
| LADDER | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS | 300132/069 |
| LAMINATES | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/034 |

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| LAMINATING | DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM | 203153/086 |
| LAMINATING | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| AMINATING | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/068 |
| AMINATING | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. | 202596/068 |
| AMINATING | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| ARGE | PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE | 201731/058 |
| LARGE | EXPLORATORY DEVELOPMENT AND TESTING OF LARGE CROSS-SECTIONAL AREA HARDWARE OF BORON/ALUMINUM | 202692/099 |
| LASER | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| LASER | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| LASER | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| LASER | ND-DOPED MIXED CRYSTAL LASER MATERIAL RESEARCH | 202890/040 |
| LASER | A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT | 203041/021 |
| LASER | EXPLORATORY DEVELOPMENT ON LASER AND OPTICAL MATERIALS | 203329/044 |
| LASERS | STUDIES ON PASSIVE Q-SWITCH MATERIALS FOR LASERS | 202594/029 |

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| LASERS | LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGH POWER IR LASERS | 201824/030 |
| LASERS | PHOTOCHEMICAL STUDIES ON ORGANIC LASERS | 203161/039 |
| LAYER | CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER | 203005/015 |
| LAYERED | MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES | 202631/020 |
| LAYING | IMPROVED TAPE LAYING MACHINE | 200986/051 |
| LAYING | IMPROVED AUTOMATED TAPE LAYING MACHINE | 200397/046 |
| LEVELS | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| LIGHT | DEVELOPMENT OF ULTRAVIOLET LIGHT STABILIZATION METHOD FOR TRANSPARENT POLYARYLSULFONES | 202934/078 |
| LIGHTLY | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| LIMIT | LIMIT ANALYSIS OF FLOW THROUGH CONICAL CONVERGING DIES | 202595/013 |
| LIMITING | FORMULATION OF THE LIMITING DUCTILITY IN METALWORKING PROCESSES | 203182/025 |
| LINES | ACOUSTIC DELAY LINES | 202864/038 |
| LINES | EXPLORATORY DEVELOPMENT OF NEW AND IMPROVED SELF-SEALING MATERIALS FOR FUEL LINES | 203214/092 |
| LIQUID | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| LIQUID | LIQUID CRYSTALS FOR AIR FORCE DISPLAYS | 203029/031 |
| LITERATURE | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |

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| LOADED | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |
| LOADING | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| LOADING | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/014 |
| LOADING | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| LOADING | AN EVALUATION OF THE EFFECTS OF CYCLIC LOADING ON THE STRENGTH OF ZINC SELENIDE | 203300/022 |
| LOW-COST | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| LOW-FLOW | DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM | 203153/086 |
| LOW-PRESSURE | DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM | 203153/086 |
| LUBRICANT | PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS | 203079/092 |
| LUBRICANT | DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES | 203255/094 |
| LUBRICANT | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/067 |
| LUBRICANT | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/067 |
| LUBRICATING | MANUFACTURING PROCESS FOR LUBRICATING COMPOSITES | 200231/052 |
| MACHINED | SURFACE INTEGRITY OF MACHINED MATERIALS | 202760/052 |
| MAGNET | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |

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| MAGNETIC | FLUORINE-19 NUCLEAR MAGNETIC RESONANCE | 202865/036 |
| MAGNETIC | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| MAGNETIC | BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS | 202825/036 |
| MAGNETIC | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| MAGNETIC | MAGNETIC NEUTRON DIFFRACTION STUDIES OF PRCO5 AND SMCO5 | 202430/031 |
| MAGNETIC | CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER | 202874/075 |
| MAGNETS | MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS | 202426/033 |
| MAGNETS | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| MAGNETS | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |
| MAKING | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| MANUFACTURE | MANUFACTURE OF BERYLLIUM STRUCTURES | 202542/045 |
| MANUFACTURING | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/017 |
| MANUFACTURING | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES VOL II | 200375/057 |
| MANUFACTURING | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| MANUFACTURING | MANUFACTURING METHODS FOR ADVANCED COMPOSITE HONEYCOMB | 201115/056 |
| MANUFACTURING | MANUFACTURING METHODS FOR FILAMENTARY REINFORCED TITANIUM MONOTAPES | 200232/049 |

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| MANUFACTURING | MANUFACTURING METHODS FOR COS/MOS MEMORY | 203108/050 |
| MANUFACTURING | MANUFACTURING PROCESS FOR THE PRODUCTION OF TAPERED TITANIUM ALLOY PLATE | 069924/046 |
| MANUFACTURING | IMPROVED MANUFACTURING METHODS FOR PRODUCING HIGH INTEGRITY MORE RELIABLE TITANIUM FORGINGS | 200233/046 |
| MANUFACTURING | MANUFACTURING PROCESSES FOR 20MM (M103) ALUMINUM ALLOY CARTRIDGE CASES | 201539/045 |
| MANUFACTURING | MANUFACTURING METHODS FOR PRODUCTION OF QUALITY SUPERALLOY ENGINE PARTS | 201738/063 |
| MANUFACTURING | MANUFACTURING METHODS FOR CASTING OF AF2-1DA ALLOY FOR HIGH-TEMPERATURE ENGINE APPLICATIONS | 200033/063 |
| MANUFACTURING | PHASE SHIFTER MANUFACTURING METHODS | 203286/061 |
| MANUFACTURING | MANUFACTURING METHODS FOR DIMENSIONALLY STABLE COMPOSITE MICROWAVE COMPONENTS | 201739/053 |
| MANUFACTURING | MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES | 203047/060 |
| MANUFACTURING | THIN FILM GARNET MANUFACTURING METHODS | 202915/059 |
| MANUFACTURING | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |
| MANUFACTURING | MANUFACTURING METHODS FOR SPIRAL WELDED TITANIUM TUBING | 202689/051 |
| MANUFACTURING | MANUFACTURING PROCESS FOR LUBRICATING COMPOSITES | 200231/052 |
| MANUFACTURING | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES | 200375/056 |
| MASKING | PROJECTION MASKING SYSTEM EVALUATION | 202923/047 |
| MASS | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202303/029 |
| MASS | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |

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| MASS | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/012 |
| MASTER | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| MATRIX | ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES | 203220/027 |
| MATRIX | FAILURE PROCESSES IN METAL MATRIX COMPOSITES | 202558/016 |
| MECHANICA_ | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| MECHANICAL | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| MECHANICAL | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| MECHANICAL | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| MECHANICAL | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/104 |
| MECHANICAL | MECHANICAL PROPERTIES OF TI-6AL-4V ANNEALED FORGINGS V | 202682/101 |
| MECHANICAL | MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE | 203227/105 |
| MECHANICAL | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| MECHANICS | FRACTURE MECHANICS TESTS AND ANALYSIS OF THE AEDC APTU STORAGE VESSEL MATERIAL | 203346/104 |
| MECHANICS | EXPLORATORY DEVELOPMENT ON FRACTURE MECHANICS OF COMPOSITE MATERIALS | 203120/093 |
| MECHANISM | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |

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| MELT | GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT | 203206/012 |
| MEMORY | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| MEMORY | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| MEMORY | MANUFACTURING METHODS FOR COS/MOS MEMORY | 203108/050 |
| MERCUROUS | MERCUROUS CHLORIDE POLARIZER MATERIAL | 203055/037 |
| METALWORKING | FORMULATION OF THE LIMITING DUCTILITY IN METALWORKING PROCESSES | 203182/025 |
| METAL-SEMICONDU | METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE | 202657/035 |
| METHYL | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| MICROSTRUCTURE | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| MICROSTRUCTURE | THE INFLUENCE OF MICROSTRUCTURE ON THE TENSILE BEHAVIOR OF RENE' 95 | 203268/021 |
| MICROWAVE | RESEARCH ON YBG FOR MICROWAVE ACOUSTIC CRYSTALS | 203334/044 |
| MICROWAVE | MANUFACTURING METHODS FOR DIMENSIONALLY STABLE COMPOSITE MICROWAVE COMPONENTS | 201739/053 |
| MICRO-OXIDATION | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| MIL-HDBK-5 | THE COLLECTION GENERATION AND ANALYSIS OF THE MIL-HDBK-5 ALLOWABLE DESIGN DATA | 202870/102 |
| MISSILE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 203024/006 |
| MISSILE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 300282/005 |

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| MIXED | ND-DOPED MIXED CRYSTAL LASER MATERIAL RESEARCH | 202890/040 |
| MODERATE | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/068 |
| MODERATE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| MODERATE | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPPOVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. | 202596/068 |
| MODERATE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| MODIFICATIONS | CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER | 202874/075 |
| MODULUS | A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS | 203181/093 |
| MODULUS | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| MODULUS | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| MOD-3A | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| MOISTURE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE. TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| MOISTURE | PREPARATION OF SOME POLYOXAZOLIDONES AND EVALUATION OF THEIR MOISTURE RESISTANCE | 202652/072 |
| MOISTURE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| MOLECULAR | SYNTHESIS OF HIGH MOLECULAR WEIGHT PARA PHENYLENE PBI | 203337/095 |

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| MOLECULES | RESEARCH ON THE THERMOLYTIC DISSOCIATION OF MOLECULES | 202969/109 |
| MONITORED | DIELECTROMETER MONITORED ADHESIVE BONDING | 202649/074 |
| MONOMERS | SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION | 200984/070 |
| MONOTAPES | MANUFACTURING METHODS FOR FILAMENTARY REINFORCED TITANIUM MONOTAPES | 200232/049 |
| MULTICOMPONENT | GROWTH OF MULTICOMPONENT CELLULAR COMPOSITES FROM THE MELT | 203206/012 |
| MULTIFILAMENT | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202981/039 |
| MULTILAYER | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/060 |
| MULTI-CONTROL-V | MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES | 202631/020 |
| MW | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/104 |
| NARROW | NARROW GAP SEMICONDUCTORS --PBSNTE AND PBSNSE | 203350/041 |
| ND1-X | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| ND-DOPED | ND-DOPED MIXED CRYSTAL LASER MATERIAL RESEARCH | 202890/040 |
| NEMATIC | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| NEUTRON | MAGNETIC NEUTRON DIFFRACTION STUDIES OF PRCO5 AND SMCO5 | 202430/031 |
| NICKEL | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |
| NICKEL-CHROMIUM | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |

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| NIOBIUM | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202961/039 |
| NITRIDE | ALUMINUM NITRIDE FOR SURFACE ACOUSTIC WAVES | 203184/042 |
| NITRIDE | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/083 |
| NOISE | CONSTRAINED LAYER TREATMENTS FOR NOISE CONTROL IN A HELICOPTER | 203005/015 |
| NONDESTRUCTIVE | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURES INSPECTION | 203298/024 |
| NONDESTRUCTIVE | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURE INSPECTION | 202429/010 |
| NONFLAMMABLE | EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS | 203188/078 |
| NONMETALLIC | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| NORMAL | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| NOT-CRITICAL | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/095 |
| NUCLEAR | BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS | 202825/036 |
| NUCLEAR | FLUORINE-19 NUCLEAR MAGNETIC RESONANCE | 202865/036 |
| OBJECTIVE | AIR FORCE TECHNICAL OBJECTIVE DOCUMENT | 203299/110 |
| OCCURS | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| OIL | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| OLIGOMERS | FUNDAMENTAL STUDIES ON REACTIVE OLIGOMERS | 203190/079 |

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| ON-LINE | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |
| OPTICAL | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| OPTICAL | EXPLORATORY DEVELOPMENT ON LASER AND OPTICAL MATERIALS | 203329/044 |
| OPTICALLY | EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS | 079616/064 |
| OPTIMIZATION | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |
| OPTIMIZATION | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| OPTIMIZATION | INVESTIGATION AND OPTIMIZATION OF MICRO-OXIDATION TECHNIQUES EMPLOYED IN GAS TURBINE ENGINE OIL | 202906/074 |
| OPTOELECTRONIC | II-VI AND III-V HETEROSTRUCTURES FOR OPTOELECTRONIC APPLICATIONS | 202697/034 |
| ORGANIC | PHOTOCHEMICAL STUDIES ON ORGANIC LASERS | 203161/039 |
| ORGANIC | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |
| ORGANIC | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| ORIENTED | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/099 |
| OXIDATION | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |

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| OXIDATION | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| OXIDE | FEASIBILITY OF MAKING AN OXIDE DISPERSION-STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| OXIDE | ELLIPSOMETRY TECHNIQUES AND THEIR APPLICATION TO OXIDE FILM GROWTH ON ALUMINUM | 202650/069 |
| PACKAGE | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| PANELS | PEEN FORMING TITANIUM PANELS | 090559/050 |
| PARA | SYNTHESIS OF HIGH MOLECULAR WEIGHT PARA PHENYLENE PBI | 203337/095 |
| PARAMETERS | INVESTIGATION OF PARAMETERS INVOLVED IN METAL PROCESSING OPERATIONS | 202538/013 |
| PARTICLE | ANALYSIS OF MULTIPLE PARTICLE IMPACTS ON BRITTLE MATERIALS | 203204/096 |
| PASSIVE | STUDIES ON PASSIVE Q-SWITCH MATERIALS FOR LASERS | 202594/029 |
| PBI | SYNTHESIS OF HIGH MOLECULAR WEIGHT PARA PHENYLENE PBI | 203337/095 |
| PBI | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS | 203342/079 |
| PBSNSE | NARROW GAP SEMICONDUCTORS --PBSNTE AND PBSNSE | 203350/041 |
| PEEN | PEEN FORMING TITANIUM PANELS | 090559/050 |
| PERFORMANCE | LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGH POWER IR LASERS | 201824/030 |
| PERFORMANCE | PERFORMANCE OF LUBRICANT COMPACT MATERIALS IN BALL BEARINGS | 203079/092 |
| PERMANENT | MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS | 202426/033 |
| PERMANENT | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |

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| PHASE | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| PHASE | STUDY OF PHASE EQUILIBRIA IN THE SYSTEM T1-AS-S AND T1-AS-SE | 202460/033 |
| PHASE | PHASE SHIFTER MANUFACTURING METHODS | 203286/061 |
| PHASE | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/089 |
| PHASE | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/058 |
| PHASED | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| PHENOLIC | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| PHENOLIC | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| PHENYLENE | SYNTHESIS OF HIGH MOLECULAR WEIGHT PARA PHENYLENE PBI | 203337/095 |
| PHOTOCHEMICAL | PHOTOCHEMICAL STUDIES ON ORGANIC LASERS | 203161/039 |
| PHOTOMICROGRAPH | STATIC AND DYNAMIC INTERPRETATION OF TITANIUM ALLOY PHOTOMICROGRAPH FEATURES | 203335/027 |
| PHYSICAL | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| PIERCED | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| PIEZOELECTRIC | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| PLAN | AIR FORCE COMPUTER AIDED MANUFACTURING (AFCAM) MASTER PLAN | 202072/056 |
| PLANE | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |

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| PLANE | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| PLASTIC | FRACTURE CRITERION FOR MATERIALS IN PLASTIC DEFORMATION PROCESSES | 203149/024 |
| PLASTIC | MULTI-CONTROL-VOLUME APPROACH TO ELASTIC AND PLASTIC WAVES IN LAYERED COMPOSITES | 202631/020 |
| PLASTIC | EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS | 079616/064 |
| PLASTICS | EVALUATION OF ELASTOMERS PLASTICS COATINGS AND METALS | 202985/103 |
| PLATE | MANUFACTURING PROCESS FOR THE PRODUCTION OF TAPERED TITANIUM ALLOY PLATE | 069924/046 |
| PLATE | ENGINEERING DESIGN DATA FOR ALUMINUM ALLOY 2124-T851 THICK PLATE | 202556/099 |
| PLATE | FRACTURE RELATED PROPERTIES OF X-2048-T851 PLATE INCLUDING SPECIMEN SIZE EFFECTS ON KIC | 203260/106 |
| POLARIZER | MERCUROUS CHLORIDE POLARIZER MATERIAL | 203055/037 |
| POLYARYLSULFONE | DEVELOPMENT OF ULTRAVIOLET LIGHT STABILIZATION METHOD FOR TRANSPARENT POLYARYLSULFONES | 202934/078 |
| POLYCRYSTALLINE | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| POLYCRYSTALLINE | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| POLYCRYSTALLINE | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| POLYCRYSTALLINE | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| POLYMER | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS | 300132/069 |

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| POLYMERIC | HIGH TEMPERATURE POLYMERIC COATING MATERIALS | 203123/089 |
| POLYMERIC | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| POLYMERIC | HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS | 202573/075 |
| POLYMERIC | EXPLORATORY DEVELOPMENT ON BASIC FAILURE BEHAVIOR OF ANISOTROPIC POLYMERIC MATERIAL | 203125/080 |
| POLYMERIC | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/084 |
| POLYMERS | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 202627/064 |
| POLYMERS | FLUOROCARBON ETHER BIBENZOXAZOLE POLYMERS | 203157/079 |
| POLYMERS | NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS | 202928/082 |
| POLYMERS | SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION | 200984/070 |
| POLYMERS | HETEROCYCLIC POLYMERS DERIVED FROM 1,2,4,5-NAPHTHALENETETRACARBOXYLIC ACID DIANHYDRIDE | 202432/066 |
| POLYMERS | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 203209/064 |
| POLYOXAZOLIDONE | PREPARATION OF SOME POLYOXAZOLIDONES AND EVALUATION OF THEIR MOISTURE RESISTANCE | 202652/072 |
| POLYUREYLENE/AC | EXPLORATORY DEVELOPMENT OF POLYUREYLENE/ACYLSEMICARBAZIDE RESINS | 203304/092 |
| POTASSIUM | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| POTENTIAL | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| POWDER | DEHYDRIDING OF TITANIUM ALLOY (TI-6246) HYDRIDED POWDER | 202856/018 |
| POWER | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |

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| POWER | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| POWER | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| POWER | LABORATORY CHARACTERIZATION AND RESEARCH ON THE PERFORMANCE OF WINDOW MATERIALS FOR HIGH POWER IR LASERS | 201824/030 |
| PRCO5 | MAGNETIC NEUTRON DIFFRACTION STUDIES OF PRCO5 AND SMCO5 | 202430/031 |
| PRECIPITATE | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| PREDICTION | COMPOSITE STRUCTURE SAFELIFE PREDICTION | 069543/003 |
| PRESSURE | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |
| PRESSURE | FORMING TITANIUM ALLOY STRINGER SECTIONS UNDER HYDROSTATIC PRESSURE | 068209/055 |
| PRESSURES | DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES | 203255/094 |
| PRIMARY | EXPLORATORY DEVELOPMENT ON LOW-COST PRIMARY FABRICATION PROCESSES FOR BORON-ALUMINUM COMPOSITES | 202842/018 |
| PROCEEDINGS | PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION | 203265/028 |
| PROCESSABILITY | HIGH TEMPERATURE RESINS HAVING IMPROVED PROCESSABILITY | 301195/081 |
| PROJECT | PROJECT THEMIS:METAL DEFORMATION PROCESSING | 202701/019 |
| PROJECTION | PROJECTION MASKING SYSTEM EVALUATION | 202923/047 |
| PROPENSITY | STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS | 202925/088 |

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| PROPERTIES | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202981/039 |
| PROPERTIES | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |
| PROPERTIES | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| PROPERTIES | MECHANICAL PROPERTIES OF TI-6AL-4V ANNEALED FORGINGS V | 202682/101 |
| PROPERTIES | FRACTURE RELATED PROPERTIES OF X-2048-T851 PLATE INCLUDING SPECIMEN SIZE EFFECTS ON KIC | 203260/106 |
| PROPERTIES | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/106 |
| PROPERTIES | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/104 |
| PROPERTIES | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS | 203342/079 |
| PROPERTY | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| PROTECTION | LABORATORY TEST TECHNIQUES FOR EVALUATING THE THERMAL PROTECTION OF MATERIALS WHEN EXPOSED TO VARIOUS HEAT SOURCES | 202918/095 |
| PROTECTIVE | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/096 |
| PYCNOMETER | CALIBRATION AND MODIFICATIONS OF THE MAGNETIC FLOAT PYCNOMETER | 202874/075 |
| QUANTITATIVE | PROCEEDINGS OF THE INTERDISCIPLINARY WORKSHOP FOR QUANTITATIVE FLAW DEFINITION | 203265/028 |
| Q-SWITCH | STUDIES ON PASSIVE Q-SWITCH MATERIALS FOR LASERS | 202594/029 |
| RADAR | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM) | 201827/008 |

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| RAIN | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/091 |
| RAIN | EFFECTS OF A RAIN EROSIVE ENVIRONMENT ON THE TRANSMISSION OF OPTICALLY TRANSPARENT PLASTIC MATERIALS | 079616/064 |
| RAIN | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| RAIN | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| RAIN | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| RANDOM | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |
| RANGE | DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER | 203202/100 |
| RANGE | BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS | 203302/081 |
| RAPID | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| RARE | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |
| RARE | MATERIALS PROCESSING OF RARE EARTH COBALT PERMANENT MAGNETS | 202426/033 |
| RARE | RARE EARTH COBALT SINGLE CRYSTALS | 202654/034 |
| RARE | MANUFACTURING METHODS FOR LOW COST RARE EARTH COBALT MAGNETS | 203039/055 |
| RATE | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| RATE | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS | 203342/079 |

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| RCO5 | RCO5 COERCIVITY | 203191/041 |
| REACTIVE | FUNDAMENTAL STUDIES ON REACTIVE OLIGOMERS | 203190/079 |
| REAGENTS | BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS | 202825/036 |
| RECRYSTALLIZATI | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| REFLECTION/THER | INFRARED DIFFUSE REFLECTION/THERMAL CAMOUFLAGE COATINGS | 203216/095 |
| REFLECTIVE | DEVELOPMENT OF INFRARED REFLECTIVE COATING MATERIALS FOR FIRE FIGHTER'S CLOTHING | 202933/083 |
| REFRACTORY | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| REINFORCED | IMPROVED GRAPHITE REINFORCED TAPE | 201821/053 |
| REINFORCED | MANUFACTURING METHODS FOR FILAMENTARY REINFORCED TITANIUM MONOTAPES | 200232/049 |
| REINFORCED | FRACTURE OF GRAPHITE FIBER REINFORCED COMPOSITES | 203167/090 |
| REINFORCED | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| REINFORCED | ANALYSIS OF RAIN EROSION OF COATED AND UNCOATED FIBER REINFORCED COMPOSITE MATERIALS | 203076/091 |
| RELAMINARIZATIO | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/114 |
| RELATIONSHIP | RELATIONSHIP OF COMPOSITION AND STRUCTURE TO STRENGTH IN TITANIUM ALLOYS | 202853/008 |
| RELIABILITY | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |
| RELIABILITY | EXPERIMENTAL EVALUATION OF A RELIABILITY ASSESSMENT MODEL FOR ADHESIVELY BONDED JOINTS | 203072/095 |

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| RELIABLE | ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS | 069421/057 |
| RELIABLE | IMPROVED MANUFACTURING METHODS FOR PRODUCING HIGH INTEGRITY MORE RELIABLE TITANIUM FORGINGS | 200233/046 |
| RENE' | THE INFLUENCE OF MICROSTRUCTURE ON THE TENSILE BEHAVIOR OF RENE' 95 | 203268/021 |
| RENE' | RENE' 95 (AF-95) SHEAR SPIN FORMING TECHNIQUES | 203235/062 |
| REPRESENTATION | ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE | 202886/075 |
| REQUIREMENT | IMPROVED INSULATOR MATERIALS REQUIREMENT PROGRAM | 203389/105 |
| RESIN | DEVELOPMENT OF LOW-FLOW, LOW-PRESSURE CURE LAMINATING RESIN SYSTEM | 203153/096 |
| RESINS | EXPLORATORY DEVELOPMENT OF POLYUREYLENE/ACYLSEMICARBAZIDE RESINS | 203304/092 |
| RESINS | HIGH TEMPERATURE RESINS HAVING IMPROVED PROCESSABILITY | 301195/081 |
| RESINS | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| RESINS | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| RESINS | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. | 202596/068 |
| RESINS | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/068 |
| RESISTANCE | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| RESISTANCE | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |

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| RESISTANCE | MATERIALS VARIABLES AFFECTING THE IMPACT RESISTANCE OF GRAPHITE AND BORON COMPOSITES | 203306/094 |
| RESISTANCE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| RESISTANCE | PREPARATION OF SOME POLYOXAZOLIDONES AND EVALUATION OF THEIR MOISTURE RESISTANCE | 202652/072 |
| RESISTANCE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| RESISTANT | WEAR AND FRETTING FATIGUE RESISTANT COATINGS FOR TITANIUM ALLOYS | 202597/016 |
| RESISTANT | DEVELOPMENT AND CHARACTERIZATION OF MATERIALS RESISTANT TO SUPERSONIC EROSION | 203122/097 |
| RESISTANT | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| RESISTANT | EXPLORATORY DEVELOPMENT OF HEAT RESISTANT AND NONFLAMMABLE FIBROUS MATERIALS | 203188/078 |
| RESISTANT | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| RESISTANT | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| RESOLUTION | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES | 200375/056 |
| RESOLUTION | MANUFACTURING METHODS PROGRAM FOR PRODUCTION OF HIGH RESOLUTION CAMERA TUBES VOL II | 200375/057 |
| RESONANCE | BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS | 202825/036 |
| RESONANCE | FLUORINE-19 NUCLEAR MAGNETIC RESONANCE | 202865/036 |
| RESPONSE | A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS | 203181/093 |

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| RESPONSE | THERMOSTRUCTURAL RESPONSE OF CARBON-CARBON MATERIALS UNDER HIGH-HEAT FLUX ENVIRONMENTS | 202570/098 |
| REYNOLDS | HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER | 202986/097 |
| RE-ENTRY | HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER | 202986/097 |
| RIBBON | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| RING | ADHESIVELY BONDED MULTILAYER F-104 FUSELAGE RING FITTING | 201114/050 |
| RIVET | FABRICATION TECHNIQUES FOR RIVET FASTENERS UTILIZING 55-NITINOL | 202858/048 |
| ROLL | ROLL DIFFUSION BONDING OF METAL MATRIX COMPOSITES | 203220/027 |
| ROLLING | ISOTHERMAL SHAPE ROLLING OF TITANIUM AND SUPERALLOYS | 203083/052 |
| ROUGHNESS | DEVELOPMENT OF A BALLISTIC RANGE CALORIMETER TO STUDY ROUGHNESS EFFECTS ON HEAT TRANSFER | 203202/100 |
| SAFELIFE | COMPOSITE STRUCTURE SAFELIFE PREDICTION | 069543/013 |
| SAFETY | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/005 |
| SAMARIUM | RESEARCH TO INVESTIGATE THE AGING CHARACTERISTICS OF SAMARIUM COBALT MAGNETS | 202653/036 |
| SAPPHIRE | SAPPHIRE FILAMENTS | 202868/077 |
| SCATTERING | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| SEAL | BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS | 203302/041 |

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| SEARCHING | THE IMPACT OF THE IMPLEMENTATION OF AN ON-LINE LITERATURE SEARCHING PROGRAM IN A RESEARCH LABORATORY ENVIRONMENT | 203195/001 |
| SEGMENTS | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBEZOTHIOPHENEIOXIDE SEGMENTS | 300132/069 |
| SELENIDE | OPTICAL PROCESSING OF ALKALI HALIDES AND POLYCRYSTALLINE ZINC SELENIDE FOR HIGH POWER LASER APPLICATIONS | 203307/042 |
| SELENIDE | AN EVALUATION OF THE EFFECTS OF CYCLIC LOADING ON THE STRENGTH OF ZINC SELENIDE | 203300/022 |
| SELF-SEALING | EXPLORATORY DEVELOPMENT OF NEW AND IMPROVED SELF-SEALING MATERIALS FOR FUEL LINES | 203214/032 |
| SEMICONDUCTOR | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| SEMICONDUCTOR | THE APPLICATION OF PHYSICAL VAPOR DEPOSITION TO SEMICONDUCTOR MATERIALS FOR USE AS HIGH POWER INFRARED WINDOWS | 202615/029 |
| SEMICONDUCTORS | NARROW GAP SEMICONDUCTORS --PBSNTE AND PBSNSE | 203350/041 |
| SEMI-ORGANIC | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 202627/064 |
| SEMI-ORGANIC | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 203209/064 |
| SENSITIVE | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |
| SERVICE | DEVELOPMENT OF A VERY HIGH STRENGTH DISK ALLOY FOR 1400F SERVICE | 203186/026 |
| SHAPE | ISOTHERMAL SHAPE ROLLING OF TITANIUM AND SUPERALLOYS | 203083/052 |
| SHEAR | RENE' 95 (AF-95) SHEAR SPIN FORMING TECHNIQUES | 203235/062 |
| SHEAR-SPUN | EVALUATION OF SHEAR-SPUN TI-3AL-2 5V TITANIUM ALLOY HYDRAULIC TUBING | 202857/102 |
| SHEET | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |

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| SHEET | DEVELOPMENT OF ECONOMICAL SHEET TITANIUM ALLOY | 200960/014 |
| SHIFT | BASIC RESEARCH TO DEVELOP SELECTIVE NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS | 202825/036 |
| SHIFTER | PHASE SHIFTER MANUFACTURING METHODS | 203286/051 |
| SHIFTERS | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| SIGNIFICANT | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| SILICA | EXTENDED HEATING ABLATION OF CARBON PHENOLIC AND SILICA PHENOLIC COMPOSITES | 203073/077 |
| SIMULATED | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| SINGLE | RARE EARTH COBALT SINGLE CRYSTALS | 202654/034 |
| SINGLE | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| SINGLE | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| SINGLE | MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES | 203047/060 |
| SINGLE | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/099 |
| SLEEVE | SLEEVE COLDWORKING FASTENER HOLES VOLUME I DISCUSSION AND SUMMARY | 201121/049 |
| SLIP-RING | RESEARCH TECHNIQUES FOR ASSESSMENT OF LUBRICANT DEGRADATION, LUBRICANT DEWETTING, AND SLIP-RING WEAR | 202572/057 |
| SLOW-SPEED | ANALYSIS OF FILM THICKNESS EFFECT IN SLOW-SPEED LIGHTLY LOADED ELASTOHYDRODYNAMIC CONTACTS PART I DEVELOPMENT OF FILM THICKNESS MEASUREMENT TECHNIQUE | 203343/093 |

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| SMCO5 | MAGNETIC NEUTRON DIFFRACTION STUDIES OF PRCO5 AND SMCO5 | 202430/031 |
| SMXCO5 | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF ND1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| SODIUM | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| SOFT | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| SOLID | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202503/029 |
| SOLID | EXPLORATORY DEVELOPMENT OF MAGNETIC BUBBLE DOMAIN MATERIAL FOR APPLICATION IN AIR FORCE SOLID STATE MASS MEMORY SYSTEMS | 202504/032 |
| SOLID | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| SOLIDIFICATION | IMPROVEMENT OF TITANIUM ALLOY INGOTS BY SOLIDIFICATION CONTROL | 069473/051 |
| SOLIDIFIED | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| SOLUTIONS | ELASTICITY SOLUTIONS FOR FIBER-REINFORCED, POLYMERIC COMPOSITE LAMINATES | 203044/094 |
| SPACE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 203024/006 |
| SPACE | ADVANCED COMPOSITE MISSILE AND SPACE DESIGN DATA | 300282/005 |
| SPECIALTY | NEW ELASTOMERIC POLYMERS AND SPECIALTY CHEMICALS | 202928/082 |
| SPECTRA | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |

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| SPECTRA | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| SPECTROMETER | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |
| SPECTROSCOPY | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| SPECTROSCOPY | INELASTIC ELECTRON SPECTROSCOPY STUDY | 202694/076 |
| SPIN | RENE' 95 (AF-95) SHEAR SPIN FORMING TECHNIQUES | 203235/062 |
| SPINEL | SPINEL FERRITES FOR PHASE SHIFTERS FOR AIRBORNE PHASED ARRAY ANTENNAS | 203082/040 |
| SPIRAL | MANUFACTURING METHODS FOR SPIRAL WELDED TITANIUM TUBING | 202689/051 |
| SPUTTER | RESEARCH IN THE PRODUCTION OF RARE EARTH COBALT PERMANENT MAGNET MATERIAL BY SPUTTER DEPOSITION | 202968/038 |
| STABILIZATION | DEVELOPMENT OF ULTRAVIOLET LIGHT STABILIZATION METHOD FOR TRANSPARENT POLYARYLSULFONES | 202934/078 |
| STABLE | MANUFACTURING METHODS FOR DIMENSIONALLY STABLE COMPOSITE MICROWAVE COMPONENTS | 201739/053 |
| STABLE | HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS | 202573/075 |
| STABLE | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| STABLE | DEVELOPMENT OF THERMALLY STABLE DYED FABRIC | 300297/065 |
| STANDARDS | DEVELOPMENT OF FATIGUE TEST STANDARDS AND MECHANICAL PROPERTY DATA ON INTERFERENCE FIT FASTENER SYSTEMS | 202945/097 |
| STATIC | STATIC AND DYNAMIC INTERPRETATION OF TITANIUM ALLOY PHOTOMICROGRAPH FEATURES | 203335/027 |
| STATIC | STATIC PROPENSITY OF VARIOUS AIR FORCE GARMENTS | 202925/088 |

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| STATISTICAL | DEVELOPMENT OF STATISTICAL FATIGUE FAILURE CHARACTERISTICS OF 0.125-INCH 2024-T3 ALUMINUM UNDER SIMULATED FLIGHT-BY-FLIGHT LOADING | 203187/022 |
| STORAGE | FRACTURE MECHANICS TESTS AND ANALYSIS OF THE AEDC APTU STORAGE VESSEL MATERIAL | 203346/104 |
| STRAIN | DEVELOPMENT OF POLYCRYSTALLINE ALKALI HALIDES BY STRAIN RECRYSTALLIZATION FOR USE AS HIGH ENERGY INFRARED LASER WINDOWS | 202977/034 |
| STRAIN | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| STRAIN | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PBI YARNS | 203342/079 |
| STRENGTH | BIAXIAL STRENGTH TESTS ON BERYLLIUM AND TITANIUM ALLOYS | 203185/025 |
| STRENGTH | DEVELOPMENT OF A VERY HIGH STRENGTH DISK ALLOY FOR 1400F SERVICE | 203186/026 |
| STRENGTH | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |
| STRENGTH | RELATIONSHIP OF COMPOSITION AND STRUCTURE TO STRENGTH IN TITANIUM ALLOYS | 202853/008 |
| STRENGTH | AN EVALUATION OF THE EFFECTS OF CYCLIC LOADING ON THE STRENGTH OF ZINC SELENIDE | 203300/022 |
| STRENGTH | HIGH STRENGTH TURBINE BLADE DOVETAILS | 201116/059 |
| STRENGTH | DEVELOPMENT OF HIGH STRENGTH, HIGH MODULUS NONMETALLIC RIBBON REINFORCED POLYMERIC COMPOSITES | 203303/087 |
| STRENGTH | IMPROVED FATIGUE STRENGTH ADHESIVE | 203261/090 |
| STRENGTH | HIGH STRENGTH CARBON ABLATIVE MATERIALS. PART I: ORIENTED SINGLE PHASE COMPACTS FROM ACRYLIC FIBROUS | 203159/099 |
| STRENGTH | HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS | 202573/075 |

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| STRENGTH | EXPLORATORY DEVELOPMENT ON FORMATION OF HIGH STRENGTH, HIGH MODULUS BORON NITRIDE CONTINUOUS FILAMENT YARNS | 203121/093 |
| STRENGTHENED | CHEMICALLY STRENGTHENED POLYCRYSTALLINE POTASSIUM CHLORIDE FOR HIGH POWER IR LASER WINDOWS | 201786/041 |
| STRENGTHENED | FEASIBILITY OF MAKING AN OXIDE DISPERSION STRENGTHENED COBALT-BASE ALLOY BY MECHANICAL ATTRITION | 202681/018 |
| STRENGTHENED | IMPROVEMENT IN THE MECHANICAL PROPERTIES AND OXIDATION RESISTANCE OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS | 202937/016 |
| STRENGTHENING | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |
| STRESS | THE STRESS INTENSITY FACTOR DUE TO NORMAL IMPACT LOADING OF THE FACES OF A CRACK | 202568/015 |
| STRESS | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART II | 202427/010 |
| STRESS | THE GENERAL PLANE STRESS FAILURE OF BORON ALUMINUM COMPOSITES PART I | 202428/009 |
| STRESS | STRESS INTENSITY FACTORS FOR SOME THRU-CRACKED FASTENER HOLES | 202971/020 |
| STRESS | STRESS ANALYSIS OF COLDWORKED FASTENER HOLES | 202926/019 |
| STRESS | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| STRESS-STRAIN | A STUDY OF THE STRESS-STRAIN BEHAVIOR OF GRAPHITE FIBER COMPOSITES TO ASSESS THE STRESS LEVELS AT WHICH SIGNIFICANT DAMAGE OCCURS | 202571/072 |
| STRIKE | BIRD STRIKE CAPABILITIES OF TRANSPARENT AIRCRAFT WINDSHIELD MATERIALS | 203242/106 |
| STRINGER | FORMING TITANIUM ALLOY STRINGER SECTIONS UNDER HYDROSTATIC PRESSURE | 068209/055 |

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| STRUCTURAL | CORROSION FATIGUE CRACK GROWTH IN AIRCRAFT STRUCTURAL MATERIALS | 079613/003 |
| STRUCTURAL | COMPOSITE BOX BEAM OPTIMIZATION VOLUME II INCREASED STRUCTURAL EFFICIENCY OF BORON/ALUMINUM | 203049/007 |
| STRUCTURAL | ISOTHERMAL FORGING OF RELIABLE STRUCTURAL FORGINGS | 069421/057 |
| STRUCTURAL | STRUCTURAL FABRICATION GUIDE FOR ADVANCED COMPOSITES | 200654/054 |
| STRUCTURE | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| STRUCTURE | RELATIONSHIP OF COMPOSITION AND STRUCTURE TO STRENGTH IN TITANIUM ALLOYS | 202853/008 |
| STRUCTURE | COMPOSITE STRUCTURE SAFELIFE PREDICTION | 069543/003 |
| STRUCTURE | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURE INSPECTION | 202429/010 |
| STRUCTURE | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/104 |
| STRUCTURES | NONDESTRUCTIVE HOLOGRAPHIC TECHNIQUES FOR STRUCTURES INSPECTION | 203298/024 |
| STRUCTURES | ADVANCED DEVELOPMENT OF NOT-CRITICAL TO FLIGHT SAFETY ADVANCED COMPOSITE AIRCRAFT STRUCTURES | 200703/005 |
| STRUCTURES | RELIABILITY ANALYSIS OF FATIGUE SENSITIVE AIRCRAFT STRUCTURES UNDER RANDOM LOADING AND PERIODIC INSPECTION | 202656/004 |
| STRUCTURES | MANUFACTURE OF BERYLLIUM STRUCTURES | 202542/045 |
| STRUCTURES | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES I BROMOACETIC ACID AND SODIUM BROMOACETATE | 202687/108 |
| STRUCTURES | THE VIBRATIONAL SPECTRA AND STRUCTURES OF ORGANIC ACIDS AND THEIR DERIVATIVES II BENZOYL CHLORIDE BENZOYL BROMIDE AND METHYL CHLOROFORMATE | 202687/108 |

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| SUBJECTED | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| SUBSONIC | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| SUBSONIC | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| SUBSONIC | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| SUBSTRATE | PRODUCTION PROCESS FOR LARGE DIAMETER CARBON FILAMENT SUBSTRATE | 201731/058 |
| SUBSTRATES | SINGLE CRYSTAL THIN FILMS OF SEMICONDUCTOR AND PIEZOELECTRIC MATERIALS ON REFRACTORY SUBSTRATES | 202505/032 |
| SUBSTRATES | MANUFACTURING METHODS FOR SINGLE CRYSTAL GARNET SUBSTRATES | 203047/060 |
| SUB-BOUNDARY | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |
| SUITABLE | STUDY OF THE MECHANISM OF DYNAMIC SCATTERING IN NEMATIC LIQUID CRYSTALS SUITABLE FOR DISPLAY APPLICATIONS | 203267/043 |
| SULFIDE | METAL-SEMICONDUCTOR JUNCTIONS ON CLEAVED CADMIUM SULFIDE | 202657/035 |
| SUPERALLOY | MANUFACTURING METHODS FOR PRODUCTION OF QUALITY SUPERALLOY ENGINE PARTS | 201738/063 |
| SUPERALLOYS | ISOTHERMAL SHAPE ROLLING OF TITANIUM AND SUPERALLOYS | 203083/062 |
| SUPERCONDUCTING | PREPARATION AND PROPERTIES OF FINE DIAMETER MULTIFILAMENT NIOBIUM CARBONITRIDE SUPERCONDUCTING FIBERS | 202981/039 |
| SUPERIOR | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |

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| SUPERSONIC | DEVELOPMENT AND CHARACTERIZATION OF MATERIALS RESISTANT TO SUPERSONIC EROSION | 203122/097 |
| SUPPLEMENT | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT 5 (APPENDIX E) FAILURE ANALYSIS | 203222/101 |
| SUPPLEMENT | THE CARBON-CARBON ASSESSMENT PROGRAM SUPPLEMENT I (APPENDIX A) MATERIALS CHARACTERIZATION | 203222/110 |
| SUPPRESSANT | ENVIRONMENTAL AGING OF CANDIDATE FIRE SUPPRESSANT DRY BAY AREA MATERIALS FOR AIRCRAFT | 202678/098 |
| SURFACE | ALUMINUM NITRIDE FOR SURFACE ACOUSTIC WAVES | 203184/042 |
| SURFACE | A LASER INTERFEROMETRIC TECHNIQUE FOR CRACK SURFACE DISPLACEMENT MEASUREMENT | 203041/021 |
| SURFACE | SURFACE INTEGRITY OF MACHINED MATERIALS | 202760/052 |
| SURFACE | A RESPONSE SURFACE FOR THE COMPLEX MODULUS OF COMPOSITE MATERIALS | 203181/033 |
| SURFACE | IMPROVED SURFACE TREATMENTS OF TITANIUM ALLOYS FOR ADHESIVE BONDING | 202461/070 |
| SURFACE | ALTERNATE GRAPHICAL REPRESENTATION OF FAILURE SURFACE | 202886/075 |
| SURFACES | ELEMENTAL AND CHEMICAL CHARACTERIZATION OF SOLID SURFACES WITH SOFT X-RAY APPEARANCE POTENTIAL SPECTROSCOPY | 203258/091 |
| SURFACES | HYPERSONIC HEAT TRANSFER MEASUREMENTS ON RE-ENTRY VEHICLE SURFACES AT HIGH REYNOLDS NUMBER | 202986/037 |
| SURFACES | GRAPHICS PACKAGE FOR COMPOSITE FAILURE SURFACES AND FAN BLADES | 202772/073 |
| SUSCEPTIBILITY | AN INVESTIGATION OF THE DYNAMIC SUSCEPTIBILITY OF NO1-X SMXCO5 SINGLE CRYSTALS AND THE EFFECT OF HYDROGEN ABSORPTION | 202436/030 |
| SYNTHESIS | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART I THE RELATION BETWEEN PRECIPITATE MICROSTRUCTURE AND MECHANICAL PROPERTIES | 203237/023 |

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| SYNTHESIS | RESEARCH ON SYNTHESIS OF HIGH-STRENGTH ALUMINUM ALLOYS PART II CONTROL OF GRAIN STRUCTURE DURING HOT WORKING | 202847/023 |
| SYNTHESIS | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| SYNTHESIS | SYNTHESIS AND CHARACTERIZATION OF ELECTROMAGNETIC MATERIALS | 203208/043 |
| SYNTHESIS | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 202627/054 |
| SYNTHESIS | SYNTHESIS OF HIGH MOLECULAR WEIGHT PARA PHENYLENE PBI | 203337/035 |
| SYNTHESIS | SYNTHESIS OF FLUOROCARBON MONOMERS AND POLYMERS BY DIRECT FLUORINATION | 200984/070 |
| SYNTHESIS | SYNTHESIS OF NEW SEMI-ORGANIC POLYMERS | 203209/054 |
| SYNTHESIS | SYNTHESIS OF LADDER BENZIMIDAZOISOQUINOLINE POLYMER CONTAINING DIBENZOTHIOPHENEDIOXIDE SEGMENTS | 300132/069 |
| TANK | FILAMENT WOUND 67-GALLON TANK FOR AQM-34M AIRCRAFT | 202995/103 |
| TAPE | IMPROVED AUTOMATED TAPE LAYING MACHINE | 200397/046 |
| TAPE | IMPROVED GRAPHITE REINFORCED TAPE | 201821/053 |
| TAPE | IMPROVED TAPE LAYING MACHINE | 200986/051 |
| TAPERED | MANUFACTURING PROCESS FOR THE PRODUCTION OF TAPERED TITANIUM ALLOY PLATE | 069924/046 |
| TAPES | PRODUCTION PROCESSES FOR COMPOSITE TAPES | 200395/048 |
| TASK | ASSESSMENT OF COATED COLUMBIUM SHEET METAL COMPONENTS FOR ADVANCED AIRCRAFT GAS TURBINE APP VOLII TASK II ANALYTICAL & EXP INVESTIGATIONS | 202975/011 |
| TECHNOLOGIES | COMPOSITE BOX BEAM OPTIMIZATION VOLUME I DESIGN ENGINEERING AND MANUFACTURING TECHNOLOGIES | 203049/007 |
| TEMPERATURE | METAL PROCESSING OPERATIONS VOLUME I GRAIN BOUNDARY AND SUB-BOUNDARY STRENGTHENING IN ALUMINUM AT ROOM TEMPERATURE | 203219/024 |

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| TEMPERATURE | HISTORY EFFECTS IN POLYCRYSTALLINE FCC METALS SUBJECTED TO RAPID CHANGES IN STRAIN RATE AND TEMPERATURE | 203253/026 |
| TEMPERATURE | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE CIRCUIT ANALOG RADAR ABSORBING MATERIALS (CA-RAM) | 201827/008 |
| TEMPERATURE | RESEARCH ON HIGH TEMPERATURE STRENGTH NICKEL BASE ALLOYS WITH SUPERIOR OXIDATION RESISTANCE | 202664/013 |
| TEMPERATURE | EXPLORATORY DEVELOPMENT FOR SYNTHESIS AND EVALUATION OF DIRECTIONALLY SOLIDIFIED COMPOSITES FOR HIGH TEMPERATURE APPLICATION | 203101/012 |
| TEMPERATURE | HIGH TEMPERATURE POLYMERIC COATING MATERIALS | 203123/099 |
| TEMPERATURE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART I | 202673/065 |
| TEMPERATURE | PROCESSABLE LAMINATING RESINS WITH IMPROVED MOISTURE RESISTANCE, TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PART II | 202837/066 |
| TEMPERATURE | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. | 202596/068 |
| TEMPERATURE | HIGH TEMPERATURE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER COATINGS | 079611/067 |
| TEMPERATURE | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/076 |
| TEMPERATURE | HIGH TEMPERATURE STABLE SUBSONIC RAIN EROSION RESISTANT FLUOROELASTOMER BOOT MATERIAL DEVELOPMENT | 202990/073 |
| TEMPERATURE | EXPLORATORY DEVELOPMENT OF HIGH TEMPERATURE TRIAZINE ELASTOMERS | 202506/071 |
| TEMPERATURE | EXPLORATORY DEVELOPMENT OF PROCESSABLE LAMINATING RESINS WITH IMPROVED TOUGHNESS AND MODERATE TEMPERATURE CAPABILITY. PHASE I | 202596/068 |
| TEMPERATURE | DEVELOPMENT OF HIGH TEMPERATURE ADDITION-CURED ADHESIVES | 203166/030 |

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| TEMPERATURE | HIGH TEMPERATURE RESINS HAVING IMPROVED PROCESSABILITY | 301195/081 |
| TEMPERATURE | BROAD TEMPERATURE RANGE HYDRAULIC SYSTEMS SEAL MATERIALS | 203302/081 |
| TEMPERATURE | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PRI YARNS | 203342/079 |
| TEMPERATURES | DETERMINATION OF CHANGES IN LUBRICANT VISCOSITIES AT HIGH PRESSURES AND TEMPERATURES | 203255/034 |
| TENSILE | THE INFLUENCE OF MICROSTRUCTURE ON THE TENSILE BEHAVIOR OF RENE' 95 | 203268/021 |
| TENSILE | THE EFFECT OF TEMPERATURE AND STRAIN RATE ON THE TENSILE PROPERTIES OF KEVLAR AND PRI YARNS | 203342/079 |
| THEMIS METAL | PROJECT THEMIS:METAL DEFORMATION PROCESSING | 202701/019 |
| THERMAL | MECHANICAL AND THERMAL CHARACTERIZATION OF AGSR GRAPHITE | 203227/115 |
| THERMAL | MECHANICAL AND THERMAL PROPERTIES OF MOD-3A A PIERCED FABRIC CARBON-CARBON MATERIAL | 203223/116 |
| THERMAL | MECHANICAL AND THERMAL PROPERTIES OF TRUSS-CORE A STRUCTURE COMPOSED OF CC MATERIAL | 203193/114 |
| THERMAL | FLUOROELASTOMER COATINGS RESISTANT TO THERMAL FLASH, HIGH TEMPERATURE, AND SUBSONIC RAIN EROSION | 202946/175 |
| THERMAL | LABORATORY TEST TECHNIQUES FOR EVALUATING THE THERMAL PROTECTION OF MATERIALS WHEN EXPOSED TO VARIOUS HEAT SOURCES | 202918/035 |
| THERMALLY | AN ARC IMAGING FURNACE FOR THE CHARACTERIZATION OF THERMALLY PROTECTIVE MATERIALS | 202974/096 |
| THERMALLY | HIGH STRENGTH, THERMALLY STABLE POLYMERIC FIBERS | 202573/075 |
| THERMALLY | DEVELOPMENT OF THERMALLY STABLE DYED FABRIC | 300297/065 |
| THERMODYNAMICS | VAPORIZATION KINETICS AND THERMODYNAMICS OF GRAPHITE USING THE HIGH PRESSURE MASS SPECTROMETER | 201400/037 |

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| THERMOLYTIC | RESEARCH ON THE THERMOLYTIC DISSOCIATION OF MOLECULES | 202969/109 |
| THERMOSTRUCTURA | STUDY OF RELAMINARIZATION ON ATJS GRAPHITE THERMOSTRUCTURAL MODELS TESTED IN THE AFFDL 50 MW FACILITY | 203071/104 |
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