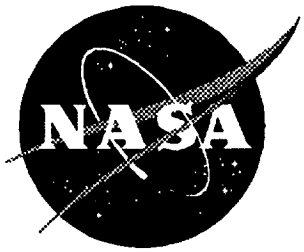

NASA Conference Publication 3354

National Educators' Workshop: Update 96

Standard Experiments in Engineering Materials Science and Technology

Compiled by
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PREFACE

NEW:Update 96, hosted by Los Alamos National Laboratory (LANL) in Los Alamos New Mexico, October 27 -30, 1996, marked the our first workshop west of the Mississippi. The new venue, high in the mountains, coupled with a quality event, provided an excellent launching of our second decade of workshops. As in the past we built themes, activities, and presentations based on extensive evaluations from participants of previous workshops. This **11th annual NEW:Update** continued to follow the theme of strengthening materials education. About 120 participants witnessed demonstrations of experiments, discussed issues of materials science and engineering (MS&E) with people from education, industry, government, and technical societies, heard about new MS&E developments, and chose from nine , three-hour mini workshops in state-of-the-art LANL laboratories to attend. Faculty in attendance represented high schools, community colleges, smaller colleges, and major universities. Undergraduate and graduate students also attended and presented.

The generous fashion in which Don Parkin, Director of LANL's Center for Materials Science, and the many scientist, engineers, and other staff, provided funding, opened their facilities, developed presentations and activities, and acted as all around gracious hosts which insured the on-going quality of this important educational series of workshops.

Professor Xavier Spiegel, representing the American Society for Engineering Education's (ASEE) Materials Division, presented a special award from ASEE in recognition to Dr. Parkin for his and LANL's valuable contributions to MS&E education. The overwhelming success of **NEW:Updates** results, in a large measure, from the considerable work and sacrifices of the host agencies: Oak Ridge National Laboratory (ORNL), National Institute of Standards and Technology (NIST), National Aeronautics and Space Administrations (NASA) Langley Research Center, Norfolk State University (NSU), and now LANL.

NEW:Update 96 participants saw the demonstration of about forty experiments and aided in evaluating them. We also heard updating information relating to materials science, engineering and technology presented as mini plenary sessions that focused on technology from LANL. Among these sessions a special emphasis was placed on hydrogen as a sub theme for the workshop; portions of that phase of the workshop were broadcast over the Internet. Additionally, a panel of materials educators provided updates on various curricula and pedagogical innovations.

The experiments in this publication can serve as a valuable guide to faculty who are interested in useful activities for their students. The material was the result of years of research aimed at better methods of teaching materials science, engineering and technology. The experiments were developed by faculty, scientists, and engineers throughout the United States. There is a blend of experiments on new materials and traditional materials. Uses of computers in MS&E, designing experiments, and a variety of low-cost experiments were among the demonstrations presented.

Experiments underwent an extensive peer review process. After submission of abstracts, selected authors were notified of their acceptance and given the format for submission of experiments. Experiments were reviewed by a panel of specialists through the cooperation of the Materials Education Council. Authors received comments from the panel prior to **NEW:Update 96**, allowing them to make necessary adjustments prior to demonstrating their experiments. Comments from workshop participants provided additional feedback which authors used to make final revisions which were submitted for the NASA editorial group for this publication.

The Materials Education Council of the United States publishes selected experiments in the ***Journal of Materials Education*** (***JME***). The ***JME*** offers valuable teaching and curriculum aids including instructional modules on emerging materials technology, experiments, book reviews, and editorials to materials educators.

Videotapes were made of the workshop by LANL. Transparency masters for the mini plenary sessions are included in this publication. As with previous NEW:Updates, critiques were made of the workshop to provide continuing improvement of this activity. The evaluations and recommendations made by participants provide valuable feedback for the planning of subsequent **NEW:Updates.**

NEW:Update 96 and the series of workshops that go back to 1986 are, to our knowledge, the only national workshops or gatherings for materials educators that have a focus on the full range of issues on strategies for better teaching about the full complement of materials. Recognizing the problem of motivating young people to pursue careers in MSE, we have included exemplary pre-university activities such as Adventures in Science, ASM International Education Foundation's Career Outreach Program, Engineers for Education, National Teachers Institute for Materials Science and Technology, and several programs run through high schools.

NEW:Update 96, with its diversity of faculty, industry, and government MSE participants, served as a forum for both formal and informal issues facing MSE education that ranged from the challenges of keeping faculty and students abreast of new technology to ideas to ensure that materials scientists, engineers, and technicians maintain the proper respect for the environment in the pursuit of their objectives.

We hope that the experiments presented in this publication will assist you in teaching about materials science, engineering and technology. We would like to have your comments on their value and means of improving them. Please send comments to James A. Jacobs, School of Technology, Norfolk State University, Norfolk, Virginia 23504.

The alpha version of a CD-ROM with over 200 experiments from past **NEW:Updates** was demonstrated by Stuart Pendelton of NASA's Technology Applications Group at the workshop. Please contact Jim Jacobs for ordering details if you wish to obtain a copy.

We express our appreciation to all those who helped to keep this series of workshops viable. Special thanks goes to those on the planning committee, management team, hosts, sponsors, and especially those of you have developed and shared your ideas for experiments, demonstrations, and novel approaches to learning.

MANAGEMENT TEAM

Workshop Co-Directors

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Center for Material Science
Los Alamos National Laboratory

James A. Jacobs
Professor of Engineering Technology
Norfolk State University

NASA LaRC Coordinator

James E. Gardner and Ginger Freeman
National Aeronautics and Space Administration
Langley Research Center

Director's Assistant

Diana P. LaClaire
Norfolk State University

Committee Members

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Oak Ridge National Laboratory

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Kristi B. Foster
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Jan C. Hull
Los Alamos National Laboratory

Kenneth L. Jewett
National Institute of Standards & Technology

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Oak Ridge National Laboratory

Thomas F. Kilduff
Thomas Nelson Community College

Kristen T. Kern
Norfolk State University

James V. Masi
Western New England College

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IBM Corporation, Retired

Alan G. Miller
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REVIEWERS FOR NEW:Update 96

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Technical notebooks and announcements of the workshop were provided by
NASA LANGLEY RESEARCH CENTER

LOS ALAMOS NATIONAL LABORATORY

MINI WORKSHOPS
TUESDAY, OCTOBER 29
2:00 - 5:00 P.M.

1. A FUNDAMENTAL APPROACH TO ION BEAM ANALYSIS - Joe Tesmer

Everyone learns fundamental principles such as conservation of momentum, or electrostatics such as Coulomb forces and Rutherford scattering in school. Unfortunately, these underlying principles are seldom evident in real-world applications. Ion beam materials analysis uses direct applications of many fundamental physics principles to solve real-world problems in materials science. This workshop will stress the links between the analytic techniques and the basics as a way to see the usefulness of learning the fundamentals. The workshop will include approximately one hour lecture and two hours of hands-on demonstration.

2. PROBING MAGNETIC AND ELECTRICAL STRUCTURALLY CONTROLLED PROPERTIES BY SCANNING PROBE MICROSCOPIES - Marilyn Hawley

Scanning probe microscopies are widely being used to evaluate not only topographic features, but property-structure relationships in electronic and magnetic materials. These materials include diamond films, magnetic tapes, and colossal magneto-resistive films. The power of the magnetic and electric force microscopes will be demonstrated on these technologically important materials and will include chemical potential variations, strain induced magnetic domains, and grain boundary effects.

3. LOS ALAMOS ELECTRON MICROSCOPY FACILITIES - Harriet Kung

Electron microscopy is a broad term used to cover many specialized techniques that define an image either by passing electrons through a material (e.g. transmission electron microscopy, TEM), or by scattering electrons off the surface of a material (e.g. scanning electron microscopy, SEM). With the new generation of electron microscopes, researchers can look at the chemistry and structure of materials at the atomic level. Electron microscopy is a vital characterization tool for relating material structure and chemistry to synthesis, processing and properties of materials, and has become a key part of materials science research. Workshop participants will be shown the LANL electron microscopy facility and examples of LANL electron microscopy capabilities.

4. SUPERCONDUCTIVITY TECHNOLOGY CENTER - Dean Peterson

Research and development activities directed towards applications of high temperature superconductors will be reviewed for participants. Demonstrations will include magnetic levitation, disappearance of electric resistance, and transport current measurements. Approaches to successfully synthesizing these new oxide superconductors in the laboratory will also be discussed. The status of ongoing collaborations with industrial partners to develop superconducting wires, magnetic separators, motors, power transmission cables, current limiters, magnetic sensors, and other applications are to be presented during the workshop.

5. SURFACE MODIFICATION FOR TRIBOLOGICAL APPLICATIONS - Michael Nastasi

Modern technology depends on materials with precisely controlled properties. For example, surface and near-surface properties are of prime consideration for integrated circuits and tribological applications. The properties of surfaces and near-surface regions may be modified through several techniques, including ion implantation and coatings. In this workshop, surface modification coating capabilities at LANL will be demonstrated, producing a sample with a modified surface region. This sample will then be tested to characterize the friction and wear properties of the modified surface.

HYDROGEN MINI WORKSHOPS

6. ENGINEERING MATERIALS FOR HYDROGEN SEPARATION - T. S. Moss and R. S. Dye

The use of hydrogen gas has become more important in recent years to a variety of high technology areas, such as microelectronics, ferrous and nonferrous metals processing, chemical and polymer synthesis, and petrochemical processing. Further, the steady depletion of limited-resource fossil fuels, such as light crudes and natural gas, and the associated pollution problems have made hydrogen-based energy systems more attractive. As such, the production of pure hydrogen gas for use in these areas has become more important.

In this workshop, the purification of hydrogen gas from impure feed streams using high temperature membranes will be examined. The fundamental differences in the way that hydrogen interacts with metals will be demonstrated. From these differences, we will be able to explain how one can design and engineer a membrane to exploit the advantageous properties of multiple materials into a composite structure with superior performance. One will gain hands-on experience with flow rate determination, gas analysis with mass spectrometry, and observe structural changes in metals due to hydrogen by x-ray diffraction.

7. HYDROGEN FUEL CELLS FOR UTILITY AND TRANSPORTATION APPLICATIONS - Shimshon Gottesfeld

To achieve high performance and high energy efficiency, hydrogen fuel cells depend critically on materials properties. For the intensively developed polymer electrolyte fuel cell, some key materials are:

a) a polymeric membrane of high protonic conductivity and chemical stability
b) a well designed thin film catalyst
c) hardware materials required to maintain high bulk surface conductivity under demanding cell operating conditions

Polymer electrolyte fuel cells and their components will be discussed, highlighting key materials issues.

8. MATERIALS FOR HYDRIDE-BASED BATTERIES - Ricardo Schwarz

Until recently, apart from the lead-acid battery, the nickel/cadmium battery had the lions share of the rechargeable electrochemical energy storage system market. Because of environmental concerns related to the toxicity of cadmium, the cadmium electrode is being replaced by the metal hydride electrode. Nickel/metal hydride batteries have an additional advantage of a slightly higher energy density storage.

The positive nickel hydroxide electrode, common to both the nickel/cadmium and the nickel/metal hydride electrode, has been studied for many years and is the positive electode of choice in most batteries. The consensus is that little can be done to improve the nickel electode. The metal hydride electode, however, requires further study and improvement. In the nickel/metal hydride battery, the metal hydride electrode operates in concentrated KOH. The main problem with this electrode relates to the loss of hydrogen storage capacity with cyclic hydrogen charging/discharging which is thought to be caused by the corrosion of the hydride material in the KOH. The workshop will review the fundamentals of the hydride battery and the current efforts at Los Alamos and elsewhere for improving the performance of the metal hydride electrode.

Mini Workshops

Mini Workshops
(Continued)

Mini Workshops
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Mini Workshops
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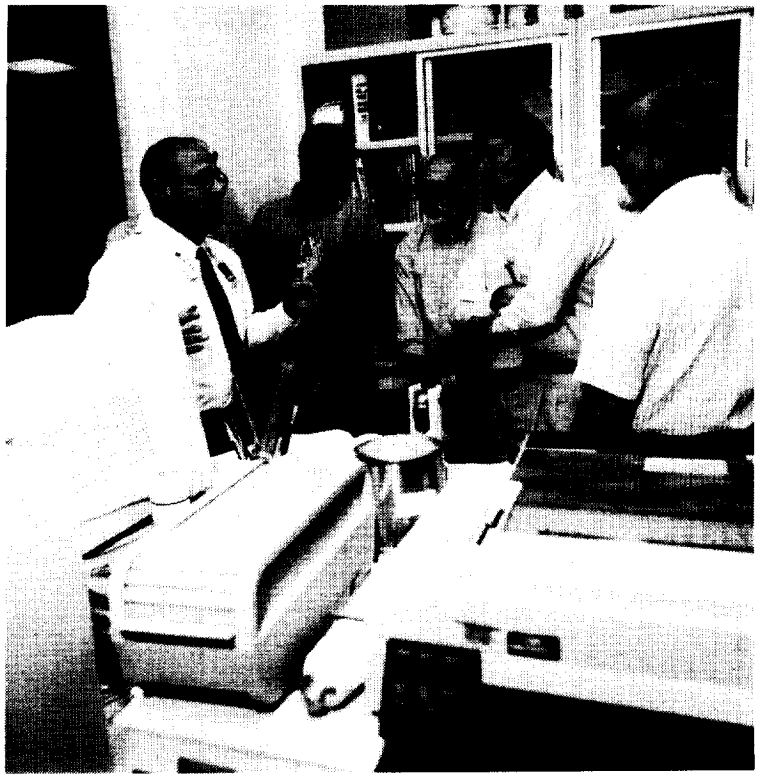

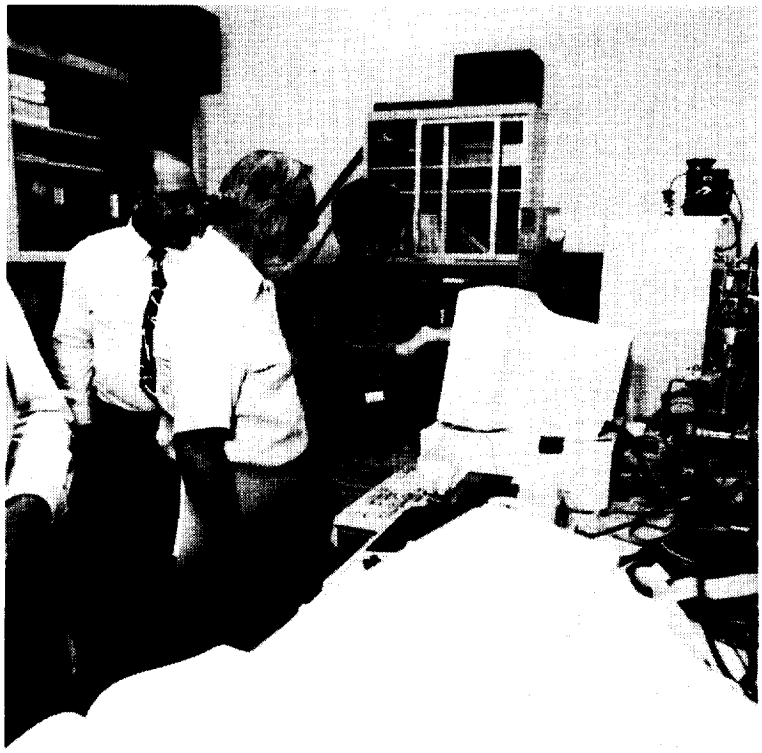

Mini Workshops
(Concluded)

LISTING OF EXPERIMENTS FROM NEW:UPDATES

EXPERIMENTS & DEMONSTRATIONS IN STRUCTURES, TESTING, AND EVALUATION

NEW:Update 88 **NASA Conference Publication 3060**

Sastri, Sankar. "Fluorescent Penetrant Inspection"
Sastri, Sankar. "Magnetic Particle Inspection"
Sastri, Sankar. "Radiographic Inspection"

NEW:Update 89 **NASA Conference Publication 3074**

Chowdhury, Mostafiz R. and Chowdhury, Farida. "Experimental Determination of Material Damping Using Vibration Analyzer"
Chung, Wenchiang R. "The Assessment of Metal Fiber Reinforced Polymeric Composites"
Stibolt, Kenneth A. "Tensile and Shear Strength of Adhesives"

NEW:Update 90 **NIST Special Publication 822**

Azzara, Drew C. "ASTM: The Development and Application of Standards"
Bates, Seth P. "Charpy V-Notch Impact Testing of Hot Rolled 1020 Steel to Explore Temperature Impact Strength Relationships"
Chowdhury, Mostafiz R. "A Nondestructive Testing Method to Detect Defects in Structural Members"
Cornwell, L. R., Griffin, R. B., and Massarweh, W. A. "Effect of Strain Rate on Tensile Properties of Plastics"
Gray, Stephanie L., Kern, Kristen T., Harries, Wynford L., and Long, Sheila Ann T. "Improved Technique for Measuring Coefficients of Thermal Extension for Polymer Films"
Halperin, Kopl. "Design Project for the Materials Course: To Pick the Best Material for a Cooking Pot"
Kundu, Nikhil. "Environmental Stress Cracking of Recycled Thermoplastics"
Panchula, Larry and Patterson, John W. "Demonstration of a Simple Screening Strategy for Multifactor Experiments in Engineering"
Taylor, Jenifer A. T. "How Does Change in Temperature Affect Resistance?"
Wickman, Jerry L. and Corbin, Scott M. "Determining the Impact of Adjusting Temperature Profiles on Photodegradability of LDPE/Starch Blown Film"
Widener, Edward L. "It's Hard to Test Hardness"
Widener, Edward L. "Unconventional Impact-Toughness Experiments"

NEW:Update 91 **NASA Conference Publication 3151**

Bunnell, L. Roy. "Tempered Glass and Thermal Shock of Ceramic Materials"
Lundeen, Calvin D. "Impact Testing of Welded Samples"
Gorman, Thomas M. "Designing, Engineering, and Testing Wood Structures"
Strehlow, Richard R. "ASTM - Terminology for Experiments and Testing"
Karplus, Alan K. "Determining Significant Material Properties, A Discovery Approach"
Spiegel, F. Xavier and Weigman, Bernard J. "An Automated System for Creep Testing"
Denton, Nancy L. and Hillsman, Vernon S. "Isotropic Thin-Walled Pressure Vessel Experiment"
Allen, David J. "Stress-Strain Characteristics of Rubber-Like Materials: Experiment and Analysis"
Dahl, Charles C. "Computer Integrated Lab Testing"
Cornwell, L. R. "Mechanical Properties of Brittle Material"

NEW:Update 92 **NASA Conference Publication 3201**

Bunnell, L. Roy. "Temperature-Dependent Electrical Conductivity of Soda-Lime Glass and Construction and Testing of Simple Airfoils to Demonstrate Structural Design, Materials Choice, and Composite Concepts"

Marpet, Mark I. "Walkway Friction: Experiment and Analysis"

Martin, Donald H. "Application of Hardness Testing in Foundry Processing Operations: A University and Industry Partnership"

Masi, James V. "Experiments in Corrosion for Younger Students By and For Older Students"

Needham, David. "Micropipet Manipulation of Lipid Membranes: Direct Measurement of the Material Properties of a Cohesive Structure That is Only Two Molecules Thick"

Perkins, Steven W. "Direct Tension Experiments on Compacted Granular Materials"

Shih, Hui-Ru. "Development of an Experimental Method to Determine the Axial Rigidity of a Strut-Node Joint"

Spiegel, F. Xavier. "An Automated Data Collection System For a Charpy Impact Tester"

Tipton, Steven M. "A Miniature Fatigue Test Machine"

Widener, Edward L. "Tool Grinding and Spark Testing"

NEW:Update 93 **NASA Conference Publication 3259**

Borst, Mark A. "Design and Construction of a Tensile Tester for the Testing of Simple Composites"

Clum, James A. "Developing Modules on Experimental Design and Process Characterization for Manufacturing/Materials Processes Laboratories"

Diller, T. E. and A. L. Wicks, "Measurement of Surface Heat Flux and Temperature"

Denton, Nancy and Vernon S. Hillsman, "An Introduction to Strength of Materials for Middle School and Beyond"

Fisher, Jonathan H. "Bridgman Solidification and Experiment to Assess Boundaries and Interface Shape"

Gray, Jennifer "Symmetry and Structure Through Optical Diffraction"

Karplus, Alan K. "Knotty Knots"

Kohne, Glenn S. "An Automated Digital Data Collection and Analysis System for the Charpy Impact Tester"

Olesak, Patricia J. "Scleroscope Hardness Testing"

Speigel, F. Xavier, "Imnexpensive Materials Science Demonstrations"

Wickman, J. L. "Plastic Part Design Analysis Using Polarized Filters and Birefringence"

Widener, Edward L. "Testing Rigidity by Torque Wrench"

NEW:Update 94 **NASA Conference Publication 3304**

Bruzan, Raymond and Baker, Douglas, "Density by Titration"
Dahiya, Jai N., "Precision Measurements of the Microwave Dielectric Constants of Polyvinyl Stearate and Polyvinylidene Fluiride as a Function of Frequency and Temperature"
Daufenbach, JoDee and Griffin, Alair, "Impact of Flaws"
Fine, Leonard W., "Concrete Repair Applications and Polymerization of Butadiene by an "Alfin" Catalyst"
Hillsman, Vernon S., "Stress Concentration: Computer Finite Element Analysis vs. Photoelasticity"
Hutchinson, Ben, Giglio, Kim, Bowling, John, and Green, David, "Photocatalytic Destruction of an Organic Dyd Using TiO_2"
Jenkins, Thomas J., Comtois, John H., and Bright, Victor M., "Micromachining of Suspended Structures in Silicon and Bulk Etching of Silicon for Micromachining"
Jacobs, James A. and Jenkins, Thomas J., "Mathematics for Engineering Materials Technology Experiments and Problem Solving"
Karplus, Alan K., "Paper Clip Fatigue Bend Test"
Kohne, Glenn S., "Fluids With Magnetic Personalities"
Liu, Ping and Waskom, Tommy L., "Ultrasonic Welding of Recycled High Density Polyethylene (HDPE)"
Martin, Donald H., Schwan, Hermann, Diehm, Michael, "Testing Sand Quality in the Foundry (A Basic University-Industry Partnership"
Shull, Robert D., "Nanostructured Materials"
Werstler, David E., "Introduction to Nondestructive Testing"
White, Charles V., "Glass Fracture Experiment for Failure Analysis"
Wickman, Jerry L. and Kundu, Nikhil K., "Failure Analysis of Injection Molded Plastic Engineered Parts"
Widener, Edward L., "Domensionless Fun With Foam"

NEW:Update 95 **NASA Conference Publication 3330**

Brown, Scott, "Crystalline Hors D'Oeuvres"
Karplus, Alan K., "Craft Stick Beams"
Kern, Kristen, "ION Beam Analysis of Materials"
Kozma, Michael, "A Revisit to the Helicopter Factorial Design Experiment"
Pond, Robert B., Sr., "Recrystallization Art Sketching"
Roy, Rustum, "CVD Diamond Synthesis and Characterization: A Video Walk-Through"
Saha, Hrishikesh, "Virtual Reality Lab Assistant"
Spiegel, F. Xavier, "A Novel Approach to Hardness Testing"
Spiegel, F. Xavier, "There are Good Vibrations and Not So Good Vibrations"
Tognarelli, David, "Computerized Materials Testing"
Wickman, Jerry L., "Cost Effective Prototyping"

NEW:Update 96 **NASA Conference Publication**

Chao, Julie, Currotto, Selene, Anderson, Cameron, Selvaduray, Guna, "The Effect of Surface Finish on Tensile Strength"
Fabris, Neda S., "From Rugs to Demonstrations in Engineering Materials Class"
Ferguson, Luke, Stoebe, Thomas, "Hysteresis Loops and Barkhausen Effects in Magnetic Materials"
Karplus, Alan K., "Holy Holes or Holes Can Make Tensile Struts Stronger"
Koon, Daniel W., "Relaxation and Resistance Measurements"
Liu, Ping, Waskom, Tommy L., "Composite of Glass Fiber with Epoxy Matrix"
Song, Kyo D., Ries, Heidi R., Scotti, Stephen J., Choi, Sang H., "Transpiration Cooling Experiment"
South, Joe, Keilson, Suzanne, Keefer, Don, "In-Vivo Testing of Biomaterials"
Thorogood, Michael G., "Tensile Test Experiments With Plastics"
Widener, Edward L., "Brinelling the Malay Snail"

NEW:Update 88 **NASA Conference Publication 3060**

Nagy, James P. "Sensitization of Stainless Steel"
Neville, J. P. "Crystal Growing"
Pond, Robert B. "A Demonstration of Chill Block Melt Spinning of Metal"
Shull, Robert D. "Low Carbon Steel: Metallurgical Structure vs. Mechanical Properties"

NEW:Update 89 **NASA Conference Publication 3074**

Balsamel, Richard. "The Magnetization Process - Hysteresis"
Beardmore, Peter. "Future Automotive Materials - Evolution or Revolution"
Bunnell, L. Roy. "Hands-On Thermal Conductivity and Work-Hardening and Annealing in Metals"
Kazem, Sayyed M. "Thermal Conductivity of Metals"
Nagy, James P. "Austempering"

NEW:Update 90 **NIST Special Publication 822**

Bates, Seth P. "Charpy V-Notch Impact Testing of Hot Rolled 1020 Steel to Explore Temperature Impact Strength Relationships"
Chung, Wenchiang R. and Morse, Margery L. "Effect of Heat Treatment on a Metal Alloy"
Rastani, Mansur. "Post Heat Treatment in Liquid Phase Sintered Tungsten-Nickel-Iron Alloys"
Spiegel, F. Xavier. "Crystal Models for the Beginning Student"
Yang, Y. Y. and Stang, R. G. "Measurement of Strain Rate Sensitivity in Metals"

NEW:Update 91 **NASA Conference Publication 3151**

Cowan, Richard L. "Be-Cu Precipitation Hardening Experiment"
Kazem, Sayyed M. "Elementary Metallography"
Krepski, Richard P. "Experiments with the Low Melting Indium-Bismuth Alloy System"
Lundeen, Calvin D. "Impact Testing of Welded Samples"
McCoy, Robert A. "Cu-Zn Binary Phase Diagram and Diffusion Couples"
Patterson, John W. "Demonstration of Magnetic Domain Boundary Movement Using an Easily Assembled Videocam-Microscope System"
Widener, Edward L. "Heat-Treating of Materials"

NEW:Update 92 **NASA Conference Publication 3201**

Dahiya, Jai N. "Phase Transition Studies in Barium and Strontium Titanates at Microwave Frequencies"
Rastani, Mansur. "Improved Measurement of Thermal Effects on Microstructure"
Walsh, Daniel W. "Visualizing Weld Metal Solidification Using Organic Analogs"

NEW:Update 93 **NASA Conference Publication 3259**

Guichelaar, Philip J. "The Anisotrophy of Toughness in Hot-Rolled Mild Steel"
Martin, Donald H. "From Sand Casting TO Finished Product (A Basic University-Industry Partnership)"
Petit, Jocelyn I. "New Developments in Aluminum for Aircraft and Automobiles"
Smith, R. Carlisle "Crater Cracking in Aluminum Welds"

NEW:Update 94 **NASA Conference Publication 3304**

Gabrykewicz, Ted, "Water Drop Test for Silver Migration"
Kavikondala, Kishen and Gambrell, Jr., S. C., "Studying Macroscopic Yielding in Welded Aluminum Joints Using Photostress"
Krepski, Richard P., "Exploring the Crystal Structure of Metals"
McClelland, H. Thomas, "Effect of Risers on Cast Aluminum Plates"
Weigman, Bernard J. and Courpas, Stamos, "Measuring Energy Loss Between Colliding Metal Objects"

NEW:Update 95 **NASA Conference Publication 3330**

Callister, William, "Unknown Determination of a Steel Specimen"

Elban, Wayne L., "Metallographic Preparation and Examination of Polymer-Matrix Composites"

Shih, Hui-Ru, "Some Experimental Results in the Rolling of Ni_3Al Alloy"

NEW:Update 96 **NASA Conference Publication**

Callister, Jr., William D., "Identification of an Unknown Steel Specimen"

Elban, Wayne L., "Metallurgical Evaluation of Historic Wrought Iron to Provide Insights into Metal-Forming Operations and Resultant Microstructure"

Griffin, R. B., Cornwell, L. R., Ridings, Holly E., "The Application of Computers to the Determination of Corrosion Rates for Metals in Aqueous Solutions"

Hilden, J., Lewis, K., Meamaripous, Selvaduray, Guna, "Measurement of Springback Angle in Sheet Bending"

Moss, T. S., Dye, R. C., "Experimental Investigation of Hydrogen Transport Through Metals"

Olesak, Patricia J., "2nd Steel Heat Treatment Lab: Austempering"

Spiegel, F. Xavier, "A Magnetic Dilemma: A Case Study"

Werstler, David E., "Lost Foam Casting"

NEW:Update 89 **NASA Conference Publication 3074**

Chung, Wenchiang R. "The Assessment of Metal Fiber Reinforced Polymeric Composites"

Greet, Richard and Cobaugh, Robert. "Rubberlike Elasticity Experiment"

Kern, Kristen T., Harries, Wynford L., and Long, Sheila Ann T. "Dynamic Mechanical Analysis of Polymeric Materials"

Kundu, Nikhil K. and Kundu, Malay. "Piezoelectric and Pyroelectric Effects of a Crystalline Polymer"

Kundu, Nikhil K. "The Effect of Thermal Damage on the Mechanical Properties of Polymer Regrinds"

Stibolt, Kenneth A. "Tensile and Shear Strength of Adhesives"

Widener, Edward L. "Industrial Plastics Waste: Identification and Segregation"

Widener, Edward L. "Recycling Waste-Paper"

NEW:Update 90 **NIST Special Publication 822**

Brostow, Witold and Kozak, Michael R. "Instruction in Processing as a Part of a Course in Polymer Science and Engineering"

Cornwell, L. R., Griffin, R. B., and Massarweh, W. A. "Effect of Strain Rate on Tensile Properties of Plastics"

Gray, Stephanie L., Kern, Kristen T., Harries, Wynford L., and Long, Sheila Ann T. "Improved Technique for Measuring Coefficients of Thermal Extension for Polymer Films"

Humble, Jeffrey S. "Biodegradable Plastics: An Informative Laboratory Approach"

Kundu, Nikhil. "Environmental Stress Cracking of Recycled Thermoplastics"

Wickman, Jerry L. and Corbin, Scott M. "Determining the Impact of Adjusting Temperature Profiles on Photodegradability of LDPE/Starch Blown Film"

NEW:Update 91 **NASA Conference Publication 3151**

Allen, David J. "Stress-Strain Characteristics of Rubber-Like Materials: Experiment and Analysis"

Chowdhury, Mostafiz R. "An Experiment on the Use of Disposable Plastics as a Reinforcement in Concrete Beams"

Gorman, Thomas M. "Designing, Engineering, and Testing Wood Structures"

Lloyd, Isabel K., Kolos, Kimberly R., Menegaux, Edmond C., Luo, Huy, McCuen, Richard H., and Regan, Thomas M. "Structure, Processing and Properties of Potatoes"

McClelland, H. T. "Laboratory Experiments from the Toy Store"

Sorensen, Carl D. "Measuring the Surface Tension of Soap Bubbles"

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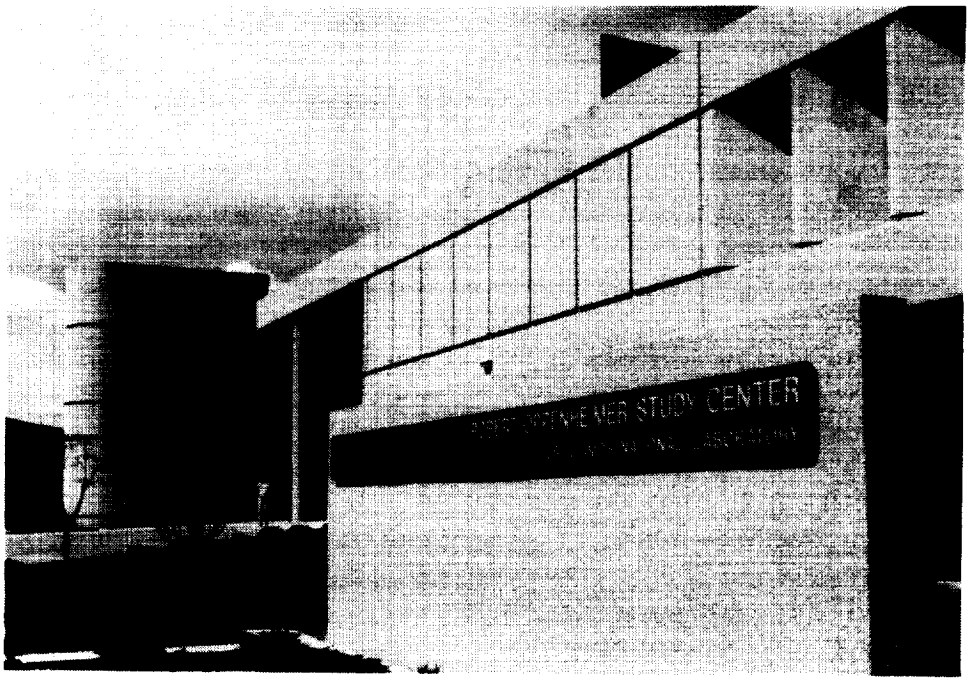

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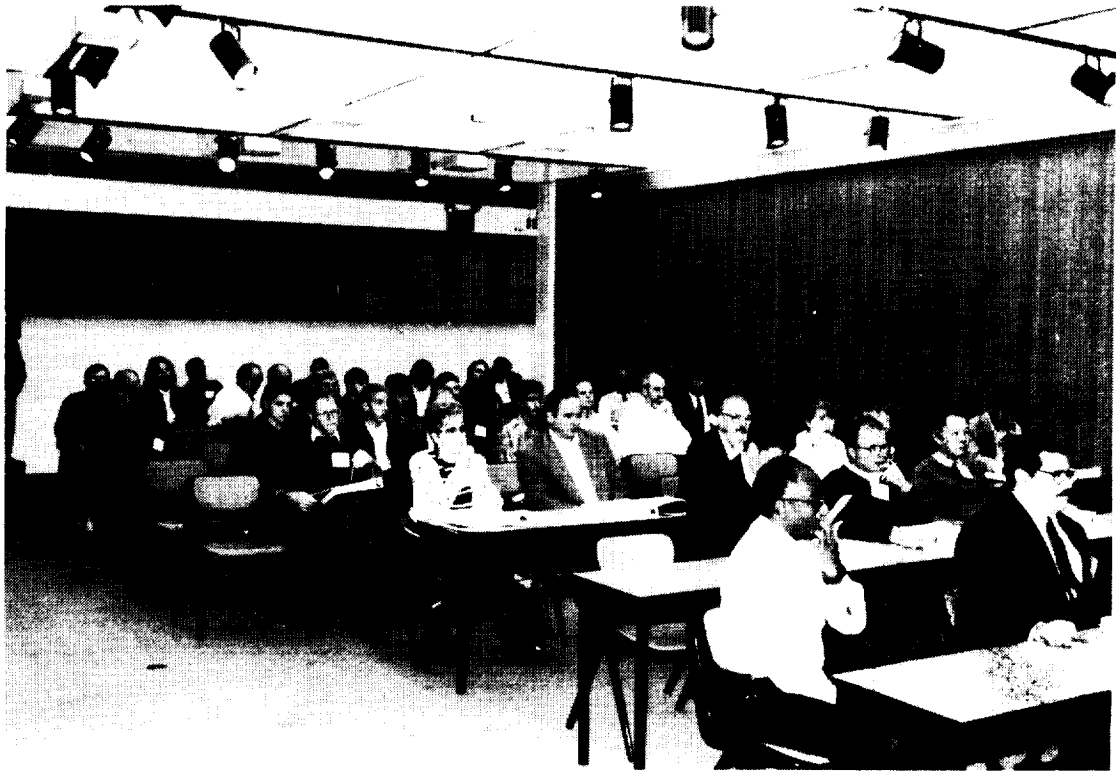

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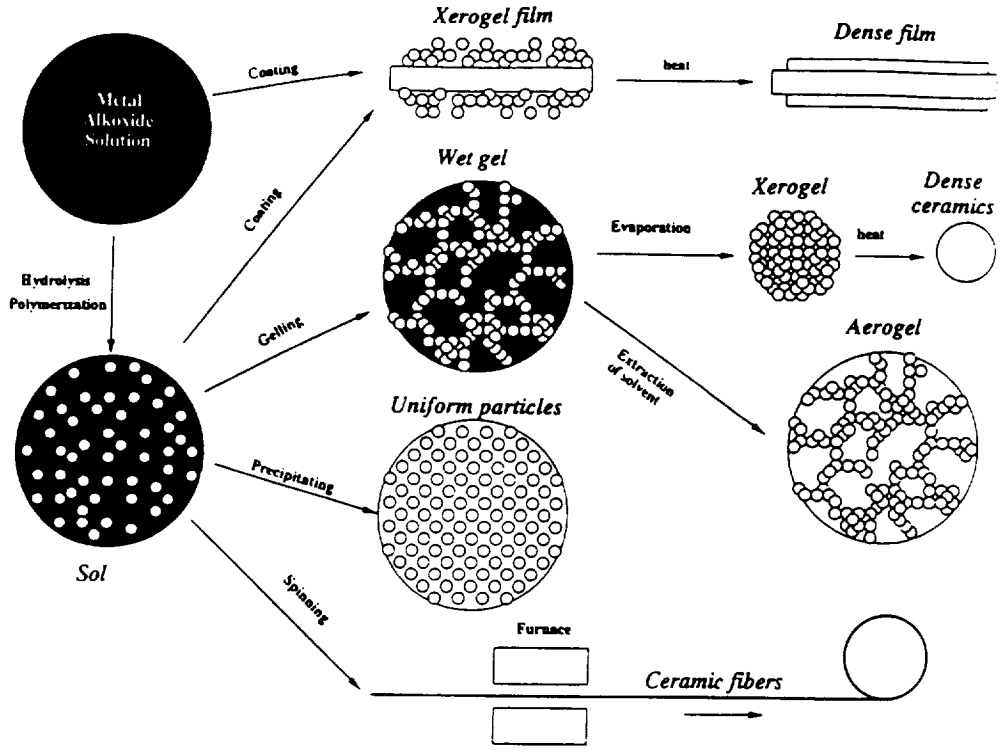
Update 96: Standard Experiments in Engineering Materials Science and Technology

October 27-30, 1996 - LANL, Los Alamos, New Mexico



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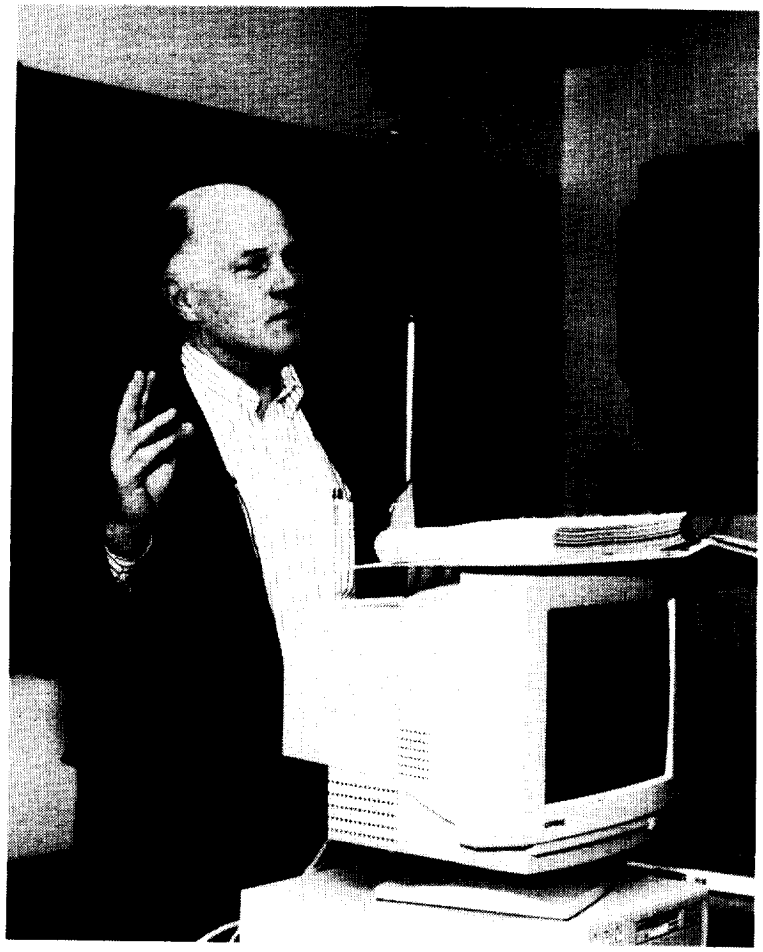
Welcome



Recognizing Contributions

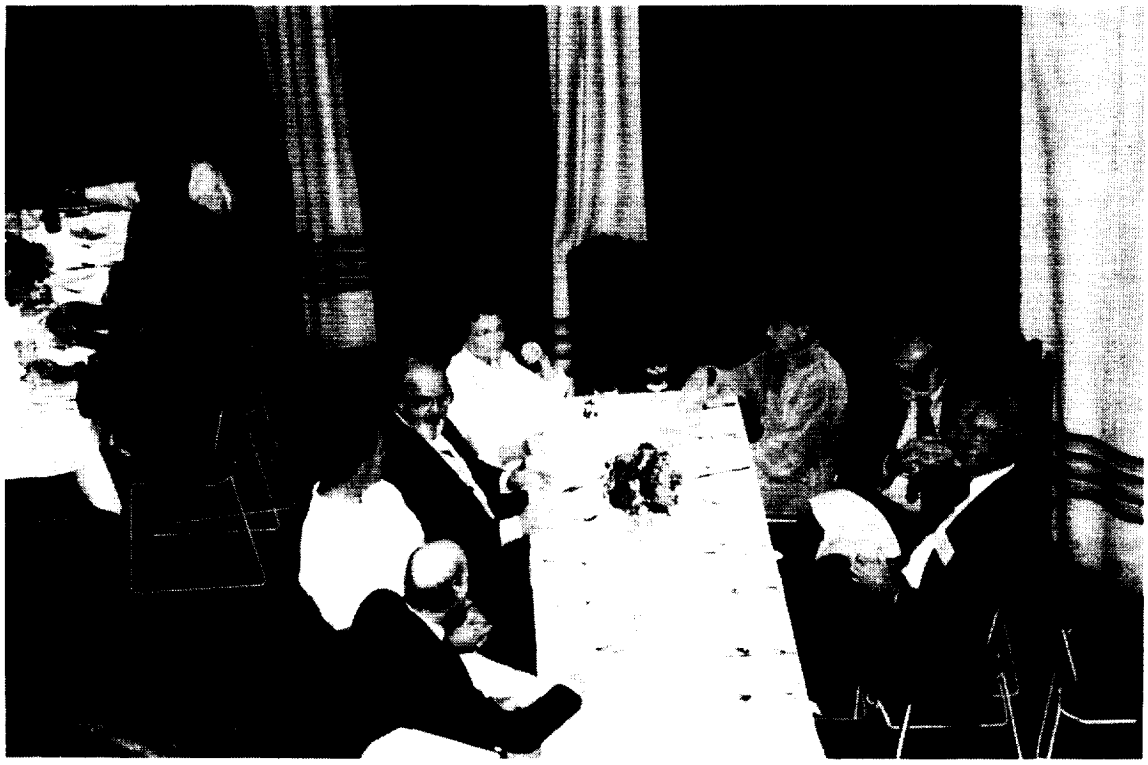
Registration

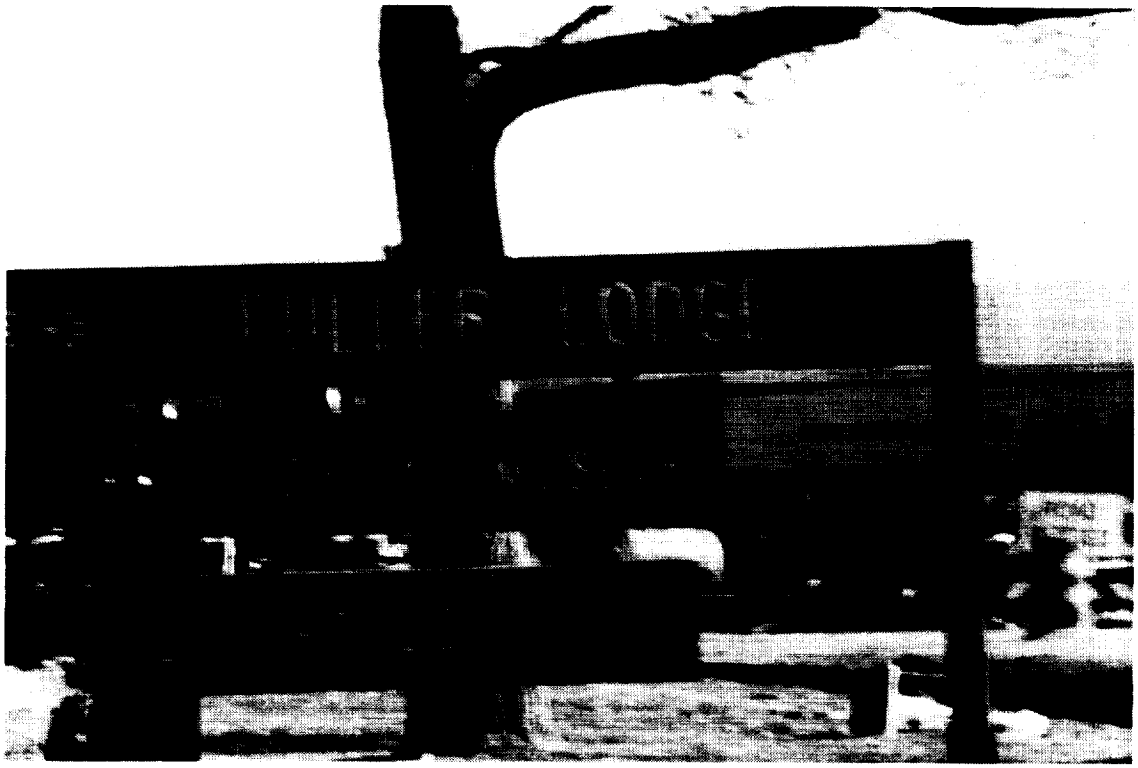
Displays

A Little Work . . .

. . . A Little Play

. . . A Little More Play





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