

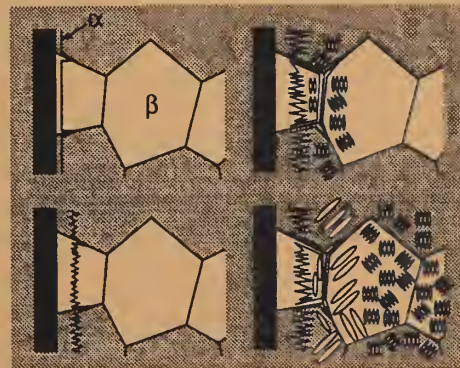
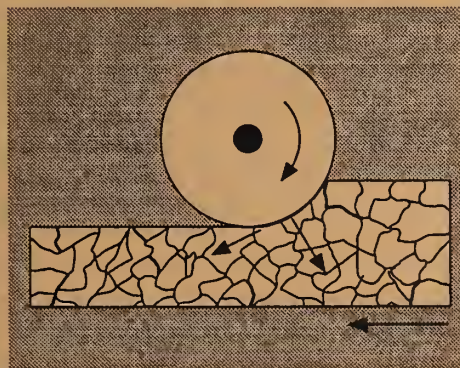
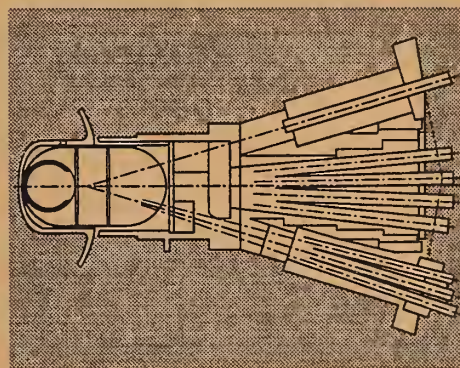
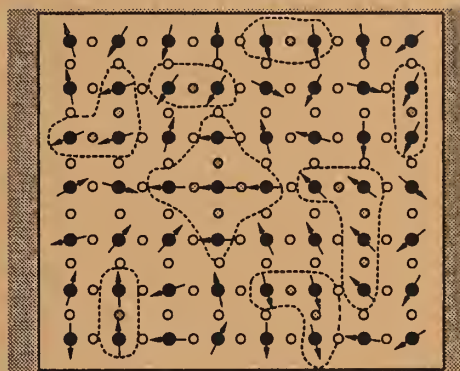


Materials Science and Engineering Laboratory

# ANNUAL REPORT

# 1993

NAS-NRC  
Assessment Panel  
April 21-22, 1994



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NISTIR 5311

U.S. Department of Commerce  
Technology Administration  
National Institute of Standards and Technology

Annual Report covers for the operating divisions of the Materials Science and Engineering Laboratory and its Office of Intelligent Processing of Materials. These annual reports describe in detail the technical activities of each of the Laboratory's major units and are available on request.

Materials Science and Engineering Laboratory

# **ANNUAL REPORT**

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L.H. Schwartz, Director

H.L. Rook, Deputy

NAS-NRC  
Assessment Panel  
April 21-22, 1994

NISTIR 5311  
U.S. Department of Commerce  
Technology Administration  
National Institute of Standards  
and Technology

## **Technical Activities 1993**



**U.S. DEPARTMENT OF COMMERCE**  
Ronald H. Brown, Secretary

**TECHNOLOGY ADMINISTRATION**  
Mary L. Good, Under Secretary for Technology

**NATIONAL INSTITUTE OF STANDARDS  
AND TECHNOLOGY**  
Arati Prabhakar, Director





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# AGENDA

## BOARD OF ASSESSMENT OF NIST PROGRAMS FOR THE MATERIALS SCIENCE AND ENGINEERING LABORATORY (MSEL)

### Wednesday, April 20, 1994

- 6:00 p.m. Dinner - Panel Chairman, Lyle Schwartz, Harry Rook  
8:00 p.m. Social get together - lounge of the Hilton Hotel

### Thursday, April 21, 1994

- 7:45 a.m. Panel meets the NIST van in front of the hotel for ride to Administration Building, NIST

### Lecture Room B, Administration Building

- 8:00 a.m. Coffee and Donuts  
8:10 a.m. NRC Charge to the Panel H. Sorrows  
8:15 a.m. Welcome & NIST Overview R. Kammer  
8:45 a.m. MSEL Overview L. Schwartz  
9:30 a.m. Discussion  
9:45 a.m. Break  
10:15 a.m. Overview of Reactor Radiation Division Programs M. Rowe  
10:35 a.m. Discussion  
10:40 a.m. Overview of Polymers Division Programs L. Smith  
11:00 a.m. Discussion

- 11:05 a.m. Overview of the Office of Intelligent Processing of Materials D. Hall
- 11:25 a.m. Discussion
- 11:30 a.m. Overview of Materials Reliability Division Programs H. McHenry
- 11:50 a.m. Discussion
- 12:00 p.m. Lunch - Dining Room C  
Panel members, L. Schwartz, H. Rook, Division Chiefs, D. Butrymowicz, J. Early, and S. Schneider

**Employee's Lounge**

- 12:45 p.m. Poster Presentations on Laboratory Research  
"Impacts to Industry"

**Lecture Room B**

- 1:45 p.m. Overview of Metallurgy Division Programs N. Pugh
- 2:05 p.m. Discussion
- 2:10 p.m. Overview of Ceramics Division Programs S. Freiman
- 2:30 p.m. Discussion
- 2:35 p.m. Executive Session -- MSEL Director on call
- 5:00 p.m. Meet with MSEL Director and Deputy Director
- 5:30 p.m. Panel meets NIST van in front of Administration Building for ride to hotel
- 6:15 p.m. Panel meets NIST van in front of hotel for ride to Flaming Pit Restaurant
- 6:30 p.m. Social Hour and Dinner - L. Schwartz, H. Rook, Division Chiefs, D. Butrymowicz, J. Early, and S. Schneider
- 9:30 p.m. Panel members ride back to hotel with Division Chiefs



**Friday, April 22, 1994**

8:00 a.m. Panel meets NIST van in front of hotel for ride to Administration Building, NIST

**Dining Room A**

8:15 a.m. Coffee and donuts

8:30 a.m. Executive Session (Panel only) - Draft Report

12:00 p.m. Lunch with L. Schwartz, H. Rook, Division Chiefs, D. Butrymowicz, J. Early, and S. Schneider

1:00 p.m. Panel Chairman meets with L. Schwartz and H. Rook  
Materials Building, Room B310

2:00 p.m. Panel Chairman meets with R. Kammer, Deputy Director, NIST,  
Administration Building, Room A1134

Panel members have an open schedule after lunchtime on Friday, April 22.

Panel members requiring special arrangements to airport on Friday, April 22, should contact Dan Butrymowicz/Linda Leaman on Thursday, April 21.





**NIST**

**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Institute of Standards and Technology**  
Gaithersburg, Maryland 20899  
OFFICE OF THE DIRECTOR

JAN 19 1994

MEMORANDUM FOR Materials Science and Engineering Laboratory Panel

From: Arati Prabhakar *Arati Prabhakar*  
Director

Subject: Annual Panel Meeting at NIST

Welcome once again to NIST. We always appreciate your insightful comments on our programs. Your suggestions are especially important as we develop our plans for the future.

As you know, President Clinton has proposed to increase the budget for the NIST laboratories from \$193 million in 1993 to more than \$430 million in 1997. This is a significant challenge for NIST. It gives us with a chance to take control of our own future as we move away from dependence on other agency funding. Our general strategy is to offset some other agency funding with STRS funds and to increase staff by roughly 10%. We are also considering strategies for greater extramural collaboration with selected organizations. For 1994, I would like the Board to focus on the adequacy of each laboratory's plans to meet the challenges and opportunities arising from the growth provided by President Clinton's budget. Your focus should include an assessment of the effectiveness of each laboratory's current technical programs, its plans for the future, its impact on industry, as well as its equipment and facility needs.

For your assessments to be of greatest use, we need your observations on NIST's technical and scientific activities, and their impact on U.S. industry, both now and in the future. You are uniquely qualified to do this because I believe that in many areas your own laboratories are excellent benchmarks. Many of you also use research from our technical programs and have insights into how we might better serve you and U.S. industry with our technical activities. I am particularly interested in your views on ways in which we might measure the impacts of our programs on industry. Finally, I am interested in hearing how effectively we have responded to your comments in previous years.

We look forward to having you work with us again this year and to hearing your input to our plans.



# OFFICE OF THE DIRECTOR

## MATERIALS SCIENCE AND ENGINEERING LABORATORY

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Vacant

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# PREFACE

The National Academy of Sciences-National Research Council (NAS-NRC) Board on Assessment of The National Institute of Standards and Technology (NIST) Programs, and in particular, the Panel for Materials Science and Engineering, performs an important role in the programs and success of the Materials Science and Engineering Laboratory (MSEL). The Panel is one of our most effective means for assuring a continuous interaction between our staff and counterparts in the scientific and engineering communities of U.S. industry and academe. Each of the Panel members is selected by the National Research Council on the basis of expertise and extensive experience in the areas of research and technology conducted by the Laboratory. In addition to this Laboratory-wide Panel, we also have an Assessment Panel for the Reactor Radiation Division.

The 1993 Annual Report was prepared for the NAS-NRC Board of Assessment of the MSEL. This report will be available to you at the April panel meeting. The Report contains background information on resources, activities, and representative highlights of the Laboratory. The report includes a summary of the strategic plan of MSEL and the technical areas proposed for future emphasis. A second series of reports on detailed technical accomplishments are published separately as National Institute of Standards and Technology Internal Reports (NISTIR) for each Division/Office. These reports are available to members reviewing individual Divisions. In early 1994, the MSEL distributed to all Board of Assessment members the latest update of the Laboratory's Strategic Plan. This report captures the findings of a 1993 off-site retreat for MSEL managers and has become a focal planning document for the Laboratory.

We look forward to your input and advice in both the evaluation and formulation process of our management decisions at all levels in the Laboratory. During this last year, I know that you have spent time in visiting our Laboratory and discussing programs, progress and plans with our staff. I appreciate the time that you give and look forward to working with you in the future.

Lyle H. Schwartz

April 5, 1993



# **Introduction**





# OVERVIEW

## I. Introduction

Materials are the keystone building blocks of modern society and are central to the reliable and efficient functioning of engineering structures, components, devices, and machines. The Materials Science and Engineering Laboratory (MSEL) at the National Institute of Standards and Technology (NIST) is responsible for providing the Nation with measurement methodology and technology, standards, concepts, reference materials, critically evaluated data, and other technical information on the fundamental aspects of processing, structure, properties, and performance of materials. In addition, the laboratory exercises leadership through coordinated participation with other Federal laboratories, industrial laboratories, and universities in national materials technology programs.

The outputs of MSEL are directed to the needs of U.S. industry, government agencies, academic institutions, and other scientific and technical organizations. The programs of MSEL support a wide base of generic technologies in high volume commodity and high value-added advanced materials, in order to provide for their safe, efficient, and economical use in service. The core program of MSEL addresses the scientific and measurement issues crucial to industry's success in exploiting the potential technological advantages of advanced materials, the development of process technologies which transform new materials from laboratory curiosities to viable products, and the manufacturing processes that reliably yield high quality products at reasonable cost.

The Laboratory consists of five technical divisions: Ceramics, Materials Reliability (located at the Boulder, Colorado laboratories), Metallurgy, Polymers, and Reactor Radiation; and one independent office, Intelligent Processing of Materials, which sponsors cross-cutting research throughout NIST. The MSEL budget in FY 1993 was approximately \$59 million, including capital equipment acquisitions. MSEL has a total staff of 396, of which 78 percent are in full time scientific or technical support positions.

In addition to the NIST staff, MSEL had 559 visiting scientists and engineers during Fiscal Year 1993 involved in collaborative research and over 900 research participants and users of the NIST research reactor and Cold Neutron Research Facility. These visitors represented U.S. industry, academe, other Federal agencies, and foreign institutions. Their stay at MSEL ranged from weeks to the entire year. These non-NIST researchers provide significant leverage of MSEL staff and resources.

## II. Major Organizational and Programmatic Events

Continuing the pattern of recent years, 1993 was a year of change and growth for the National Institute of Standards and Technology and the programs and staff of the Materials Science and Engineering Laboratory.

The Clinton Administration has made accelerated development, commercialization, and adoption of new technology by U.S. industry driving elements of its plan for sustained U.S. economic growth for all U.S. citizens. To accomplish these goals, both the Administration and the Congress have resolved to make the Department of Commerce (DoC) and NIST key players in the President's plans. The NIST Fiscal Year 1994 budget appropriation, which includes substantial increases across the board and a seventeen percent increase for the Laboratories, articulates the President's commitment to NIST's research and industrial outreach programs and reinforces the Administration's confidence in NIST to accomplish its tasks.

The President's strategy for maximizing the return to society and to the economy from its R&D investments incorporate priorities familiar to NIST and the MSEL.

- Coordinated technology management across government using the Office of Science and Technology Policy (OSTP) and the newly established National Science and Technology Council (NSTC)
- Establish government priorities for civilian research through close coupling with private business
- New and expanded cost-shared public-private R&D partnerships to reflect the real needs of American business
- National attention on technologies crucial to today's businesses and expanding globalized economy such as advanced manufacturing, electronic information and communication, transportation, education and training, and natural resources and the environment.

The NIST team for accomplishing these tasks is led by its new director, Dr. Arati Prabhakar. Confirmed early during the Clinton administration, Dr. Prabhakar is quickly moving to transform NIST from primarily a measurement laboratory program with three relatively small extramural programs to a full-service technology development, funding, extension, and quality improvement partner for U.S. industry. Under Dr. Prabhakar's leadership, NIST has implemented plans for setting priorities and measuring results as the Institute becomes a recognized player in the new technology environment of purposeful public-private investments. Dr. Prabhakar has reviewed and revised the process for developing and allocating Scientific and Technical Research and Services (STRS) funds within NIST Laboratories, solicited staff input on the process, and shared her findings with all NIST employees affected by the process. An element of this effort has included the complete review of all NIST Laboratory programs. MSEL will share the results of this review with its Assessment Panel members. NIST has also begun a major construction and renovation program as part of its transformation to bring the Institute's laboratory facilities up to the needs of the 21st century and beyond.

Throughout 1993, MSEL continued to play a leadership role within the White House Office of Science and Technology Policy in the development of a coordinated federal materials research and development strategy as the Clinton Administration continued to refine its



commitment to civilian technology development. Since 1991, Dr. Lyle H. Schwartz, MSEL Director, has chaired the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) Working Group on Materials (COMAT). Now in 1994, FCCSET has been disestablished and replaced by the President's National Science and Technology Council. Dr. Schwartz now leads the Materials Technology (MatTec) Subcommittee within the NSTC Civilian Industrial Technology Committee chaired by Department of Commerce Under Secretary for Technology Mary Good. Within this new framework, the MatTec will provide strategic guidance, interagency planning and coordination, and private sector linkage on policies and programs undertaken within the Administration's technology investment agenda impacted by advanced materials technology. This includes focused national attention on automotive technologies, aeronautics, electronics, and civil infrastructure.

As part of NIST's drive in establishing priorities and continually evaluating and improving the planning process, the Materials Science and Engineering Laboratory revisited its own strategic direction articulated in 1991 during a three-day 1993 off-site retreat for MSEL managers. Based on an approach used by industrial R&D organizations for strategic planning, the January 1994 plan gives a new strategic thinking for MSEL in research agenda development, resource allocation, and program evaluation mechanisms. The MSEL plan affirms the Laboratory's vision to be the federal government's central resource to support technology development in advanced materials and advanced processing of materials for application in the civilian economy. It also calls for exercising leadership in convening and coordinating commercially oriented federal materials programs. In response to the plan, MSEL has increased its efforts in tracking programmatic impacts on U.S. industry and recording significant successes (see Appendix C). With greater public attention directed to the programs and outputs of NIST under the President's technology program, the guiding principles contained in MSEL's plan allows it to implement its technical agenda in an efficient and effective manor.

The Laboratory has continued to expand its research opportunities and its delivery to industry of accomplishments derived from specialized facilities including the NIST Reactor and the Cold Neutron Research Facility (CNRF). A new Laboratory program directing expertise in polymers, metals, and materials reliability on problems confronting the U.S. microelectronic packaging and interconnection (P/I) manufacturer, user, and materials supplier industries commenced in FY 1993 through initiative funding in advanced materials, high performance computing and communications, and microelectronics programs. Focused on issues in materials metrology and data in the semiconductor and printed wiring board business sectors, this new Laboratory program is directed to the requirements of P/I designers, manufacturers, and reliability assessors. As part of this program, MSEL is spearheading the establishment of a "National Forum on Electronic Packaging and Interconnection Materials Metrology" to leverage the accomplishments of NIST and its CRADA partners. In the Polymers Division, technical staff are cooperating with partners from industry, university, and National Laboratories examining fundamental aspects of polymer interfaces and adhesion using state-of-the-art neutron reflectometry. Division staff are also cooperating with U.S. microelectronic firms, materials suppliers, industry consortia, universities, and other

government agencies to improve the metrology and standards used by U.S. firms for characterizing the dimensional stability of polymers used in advanced packaging. Researchers from the Metallurgy Division are participating in a National Center for Manufacturing Sciences consortium to develop lead-free solder alloys in anticipation of future lead use restrictions. Researchers from NIST, Sandia National Laboratories, and nine industrial partners are using phase diagrams and other thermodynamic data provided by NIST to develop selection criteria for these new solder alloys. In the Materials Reliability Division, a focused program in thin film testing and experimental micromechanics is underway to provide accurate input data for quantitative modeling and simulation of the manufacturability and reliability of advanced P/I systems.

The NIST Reactor and Cold Neutron Research Facility continue to provide industry with state-of-the-art facilities and research results that often cannot be obtained elsewhere in the world. The NIST Reactor operated more than 75% of real time in the past year - a new record for on-line time - providing over 900 U.S. research participants with neutrons for 98% of scheduled time. At the same time, the CNRF user program continued to grow in numbers and diversity. In 1993, 155 proposals were received for user experiments during FY93, a 70% increase over 1992. The Reactor Radiation Division, in cooperation with IBM Research and University of Minnesota has built a new state-of-the-art neutron reflectometer at the CNRF at NIST. The new reflectometer gives NIST and its industrial and university collaborators a very powerful tool for the investigation of surface behavior of polymers, magnetic thin films, surfactant films and other technologically relevant thin film materials. Though in operation for only a short time, the instrument is already heavily oversubscribed. Also the Reactor Radiation Division, in cooperation with M.I.T., has completed development of a new ultra-high resolution powder neutron diffractometer for use at the NIST reactor. A number of state-of-the-art features increase the rate of data collection by a factor of 25, with better resolution and an excellent line-shape when compared to existing instrumentation. So far scientists from over 20 organizations, including six industrial labs have already utilized this new instrument. Research between NIST scientists, the University of California at Santa Barbara, and Mobil Oil Corporation have provided NIST partners with important information using neutron scattering techniques on a new generation of "Giant Catalysts" containing mesopores. These materials are being intensely studied by industry and university for their potential use in large-molecule catalysis and chemical separation, and as hosts for semiconductors to form "quantum wires." Also, Reactor Radiation Division scientists and colleagues from the Federal Highway Administration are applying state-of-the-art quasi-elastic neutron scattering to the most ubiquitous structural material in the world, cement. The motion of water on the molecular scale has been tracked from initial mixing of the cement to nearly complete cure ~ 8 months later to yield important insights into the fraction of trapped and unreacted water molecules remaining in concrete.



## SELECTED HIGHLIGHTS

- In joint research with the members of the Ceramic Machining Consortium, it was found that under certain conditions grinding rates for silicon nitride ceramics can be increased by a factor of 60 over those currently used, thereby increasing productivity and decreasing manufacturing costs.
- Measurements of Raman peak shifts have demonstrated that internal stresses at specific depths in transparent materials can be detected. Peak shifts in these Raman-active coatings have been correlated with the stresses applied to the underlying substrates suggesting stresses applied to materials with no Raman signature might be determined by the application of a Raman-active coating.
- In a collaborative program with Nanophase Technology Inc., small-angle neutron scattering has revealed how microstructure development in nanophase ceramics can be engineered by control of processing parameters. In particular, the influence of sintering temperature and environment in controlling grain growth, and the role of additives in suppressing potentially deleterious phase transitions were explored.
- Working with Itek Optical Systems, NIST successfully completed a reliability assessment for large-scale glass aircraft windows using state-of-the-art fracture mechanics and statistical techniques. These are the first non-laminated glass windows approved for aircraft by the Federal Aviation Administration.
- Research was initiated with the American Iron and Steel Institute on a major research program aimed at improving on steel processing. The two NIST projects involve developing process models for the thermomechanical processing of steel and developing magnetic sensors for on-line determination of the mechanical properties of steel sheet. Initial research on these two projects has had significant progress in process modeling for the thermomechanical processing of steel. In addition, research on the on-line magnetic sensor showed a close correlation of the specimen's magnetic properties and yield strength.
- NIST researchers collaborating with U.S. industry in the NIST Consortium on Intelligent Processing of Rapidly Solidified Metals Powders by High Pressure Gas Atomization have continued to successfully transfer consortium-developed methodology on sensing and fluid dynamics-based process modeling to consortium members. This methodology is crucial for on-line process control and has resulted in cost savings to our industrial members.



- Focusing on the average elastic fields, NIST scientists have developed a new micromechanics theory for modeling the physical properties of composite materials. Predictions of the elastic constants of test materials show excellent agreement with actual measurements.
- The American Welding Society awarded first place to NIST for a presentation, "Control of Arc Length During Gas Metal Arc Welding" at the 1993 annual meeting. Intelligent process control was achieved by using arc light and current sensing in conjunction with control algorithms based on an electrode-extension model. This work is an extension of research conducted in conjunction with the U.S. automobile industry and targets the fabricated metals products sector.
- A second-generation apparatus featuring a thermal loading system was developed by NIST scientists for micro-mechanical property measurements on thin films used in microelectronic packaging. The improved sensitivity enables in-situ testing of specimens 100  $\mu\text{m}$  wide and 0.2  $\mu\text{m}$  thick and measurement of load-displacement records between 0 and 1 gram-force.
- The high magnification viewing capabilities of an electron-beam moire technique were successfully used to study strain fields in the fracture process zones and interfacial deformation of silicon carbide particle reinforced metal matrix composites. This technique has also been applied to electronic packaging test specimens including printed circuit boards.
- Using state-of-the-art neutron and X-ray reflectivity techniques, experiments on the interface of polymers with silicon over a range of temperatures indicate that Angstrom-scale thin films of polystyrene exhibit a lower  $T_g$  than that of the bulk, while the  $T_g$  of polymethylmethacrylate is not affected. The effect is believed to correlate with the energy of adhesion and impacts a number of advanced technology applications using polymers.
- A NIST/Industry Consortium on Polymer Blends and Alloys, formed in 1993, currently has five industrial members and another six companies and Sandia National Laboratories are in the process of joining. The objective of the consortium is to understand and control the processing and kinetics of mixing/demixing. Mixing/demixing is critical in all polymer blends/alloys processing for control of microstructure, morphology, and properties of the final material. This year's research included understanding the shear mixing/demixing and phase separation kinetics after cessation of shear, and interfacial modification and control during processing. Fundamental knowledge obtained from these studies is being directed to development of new products and intelligent processing systems for on-line control.

- In cooperation with the Automotive Composites Consortium (Ford, General Motors, and Chrysler), a design was developed to instrument a mold for fabrication of a structural automotive part, the cross member in a van. This part is very complex so the mold provides an excellent tool to investigate structural reaction injection molding, and to test NIST's process simulation models. Previous work in this cooperative program has used these simulation models to describe mold filling for other structural automotive parts.
- Swelling measurements on the natural rubber/benzene and poly(dimethyl siloxane/benzene) systems using a NIST sub-ambient pressure isopiestic facility confirm prior results from MSEL that the Flory-Huggins interaction parameter  $\chi$  of polymers is crosslink dependent. The temperature dependence of  $\Delta\chi$  has been explored and found to have a very strong temperature and crosslink dependence. There is no current theoretical understanding of this behavior.
- Grain boundaries in high temperature superconductors severely degrade electrical transport, thereby limiting use in large-scale commercial applications such as motors and power transmission systems. In collaboration with the Russian Academy of Sciences, a high-resolution magneto-optical imaging system was used to obtain the first quantitative measurements of the effect of grain boundaries on the magnetization dynamics of YBCO polycrystals, whereby the dynamics of flux penetration was directly correlated with details of grain boundary structure.
- The continuous monitoring and control of process temperature during rolling and extrusion of metals is critical to the attainment of uniform, and predictable mechanical properties. Eddy current techniques for measuring the temperature of sheet aluminum as it proceeds through the hot rolling process was demonstrated in actual, operating mills in Ontario, Canada and Pennsylvania. When fully implemented through the cooperation of the Aluminum Association of America and Data Measurements Company, improved temperature control can be maintained in production yielding a more uniform product.
- NIST collaboration with industrial and university members of the Consortium on Casting of Aerospace Alloys are improving the understanding and control of castings for critical aerospace applications. This work includes determination of multicomponent phase equilibria needed for predicting alloy segregation patterns, modeling interactions between titanium castings and the mold, and analyzing the growth of single crystals in molds of complex shape. High temperature thermophysical properties, needed to carry out modeling of the casting process, are being measured for specific alloys of interest to consortium members and eddy-current and x-ray sensors are being developed for monitoring the growth of single crystal aircraft engine components.

- The unique power of neutron powder diffraction profile refinement has been used by NIST to determine the crystal structures and phase diagrams of the new mercury-containing compounds with superconducting transitions temperature that can exceed 150 K. The critical role of oxygen in doping these materials has been elucidated for the single, double, and triple layer materials, and crystal structures have been solved for the four and five layer materials, as well as for a number of substitutionally doped materials with important technological potential.
- Scientists from NIST, the Department of Transportation, David Taylor Navy Research Center, and ONRL are collaborating in studies of residual stresses around a variety of weldments. This interagency collaboration is using the unique penetrating power of neutrons to map out triaxial residual stress distributions, not possible by any other nondestructive probe. The weldments range from a spot weld on a plate -- the simplest possible geometry for modeling -- to welded stiffeners for bridge girders, for which the neutron results provide critical information relating to the strength and durability of these weldments.
- One of the classic materials to exhibit a Metal-Insulator transition is the metal-oxide  $V_{2-y}O_3$  system. A collaboration between NIST, Johns Hopkins University, the University of Chicago, and AT&T Bell Laboratories has revealed how the magnetic structure and spin dynamics evolve as this transition proceeds. This research has shown the transition is directly related to a Mott-Hubbard type Fermi surface instability.

# Personnel





# SUMMARY OF MSEL STAFF

1991-1993

<u>Full Time Permanent</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>
Physicist	58	61	62
Chemist	50	48	45
Metallurgist/Matls. Scientist	44	44	48
Engineer	34	44	38
Other	<u>15</u>	<u>17</u>	<u>15</u>
<b>Subtotal</b>	<b>201</b>	<b>214</b>	<b>208</b>
Technical Support	38	39	40
Reactor Operators	15	15	16
Management Support	8	8	8
Secretarial/Admin. Support	<u>35</u>	<u>39</u>	<u>35</u>
<b>Subtotal</b>	<b>96</b>	<b>101</b>	<b>99</b>
<b>TOTAL FTP</b>	<b>297</b>	<b>315</b>	<b>307</b>
<u>Other</u>			
NRC-NAS Postdoctorals	16	10	13
Part-Time and Temporary	30	46	54
Academic (Student and Faculty)	<u>32</u>	<u>19</u>	<u>22</u>
<b>Subtotal</b>	<b>76</b>	<b>75</b>	<b>89</b>
<b>TOTAL STAFF</b>	<b>375</b>	<b>390</b>	<b>396</b>

# NRC-NAS POSTDOCTORAL PROGRAM

MSEL - FY 1993

Unit	Name	Degree	School	Position Title	Advisor
Lab Office	Foecke, Timothy	Matls. Sci./Engr.	U. of MN	Matls. Res. Engr.	Thomson
	Luecke, William	Matls. Sci./Engr.	Cornell U.	Matls. Res. Engr.	Weiderhorn
Materials Reliability	Berger, John	Matls. Sci./Engr.	U. of MD	Matls. Res. Engr.	Tewary
	Keller, Robert	Matls. Sci./Engr.	U. of MN	Matls. Res. Engr.	Read
Polymers	Dadmun, Mark	Poly Sci./Engr.	U. of MA	Matls. Res. Engr.	Han
	Glotzer, Sharon	Physics	Boston U.	Physicist	DiMarzio
	Mott, Peter	Matls. Sci.	MIT	Phys. Scientist	McKenna
	Nachlis, Warren	Poly. Sci./Engr.	U. of MA	Phys. Scientist	Han
	Orts, William	Chemistry	U. of Toronto	Chemist	Wu
	Van Zanten, John	Chem. Engr.	UCLA	Chem. Engr.	Wu
Metallurgy	Josell, Daniel	Mech Engr./Phy.	Harvard U.	Phys. Scientist	Handwerker
	Roosen, Andrew	Mathematics	Rutgers U.	Mathematician	Cahn
Reactor	Reznik, Demitry	Physics	U. of IL	Physicist	Neumann

# ACADEMIC PROGRAM

MSEL  
FY 1993 Appointments

	Students	NRC/NAS Postdoctorals	Faculty	Totals
Laboratory Office	2	2	----	4
Ceramics	5	----	----	5
Materials Reliability	----	2	1	3
Polymers	12	6	----	18
Metallurgy	----	2	1	3
Reactor Radiation	<u>----</u>	<u>1</u>	<u>1</u>	<u>2</u>
Totals	19	13	3	35

# VISITING SCIENTIST PROGRAM

## MSEL

1991-1993

<u>Guest Researchers</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>
<u>Domestic</u>			
Federal	47	46	42
Academic	92	116	128
Industry	46	70	68
Self-Employed	<u>20</u>	<u>26</u>	<u>25</u>
Subtotal	205	258	263
 Foreign	 164	 202	 244
 <b>Subtotal</b>	 <b>369</b>	 <b>460</b>	 <b>507</b>
 <u>Research Associates</u>			
Federal	4	4	3
Academic	----	----	1
Industry	53	45	6
 <u>Research Agreements</u>			
Federal	----	----	----
Academic	----	----	----
Industry	<u>20</u>	<u>11</u>	<u>41</u>
Subtotal	77	60	51
 <u>Intergovernmental Personnel</u>			
<u>Act (Academic)</u>	<u>2</u>	<u>1</u>	<u>1</u>
 <b>TOTAL</b>	 <b>448</b>	 <b>521</b>	 <b>559</b>

## **NIST FELLOWS**

(Established by NIST Director to provide recognition to most outstanding scientists)

1993

**John Cahn**                      Elected to Senior Fellow

**Brian R. Lawn**                Elected to Fellow

**John J. Rush**                 Elected to Fellow

**Robb M. Thomson**            Elected to Fellow

**Sheldon M. Wiederhorn**    Elected to Senior Fellow



# HONORS AND AWARDS

1991-1993

## DEPARTMENT OF COMMERCE AWARDS

### GOLD MEDAL (Exceptional Service)

- Wen-Li Wu** for the development of a test based on the complex thermal expansion properties of composites to assess interface strength. (1992)
- Edward Prince** for development of maximum entropy techniques for the solution of biological structures from X-ray scattering data. (1991)
- Tawfik M. Raby** for leadership in operation of the NIST Research Reactor as a major national measurement resource for U.S. science and industry. (1991)

### SILVER MEDAL (Meritorious Service)

- Sam R. Coriell** for scientific breakthroughs crucial to alloy solidification and materials processing. (1993)
- Christopher M. Fortunko** for innovative scientific contributions and leadership in developing measurement techniques to characterize the quality of complex materials such as composites, thin films, and superconductors. (1993)
- Charles F. Majkrzak** for achieving a major breakthrough in new supermirror coatings for transport and tailoring of neutron beams for research on high-technology materials. (1993)
- Gregory B. McKenna** for exceptional contributions to understanding mechanical behavior of polymers. (1992)



**Stephen D. Ridder**  
**Francis S. Biancaniello**  
**George E. Mattingly**  
**Cary Presser**  
**Pedro I. Espina**  
**Stephen A. Osella**

for outstanding contributions to the development and demonstration of intelligent processing technology in the production of rapidly solidified metal powders. (1991)

### **BRONZE MEDAL (Superior Service)**

**R. Bruce Madigan**  
**Timothy P. Quinn**  
**Thomas A. Siewert**

for development of an arc-diagnostic system to improve the quality and reliability of welded construction. (1993)

**Richard S. Parnas**

for contributions that have enhanced greatly the ability of industry to fabricate low-cost composites by liquid molding. (1993)

**Anthony J. Bur**

creative development of fluorescence methods for monitoring polymer processing and for his contribution to technology transfer. (1992)

**Grady White**

instrumental in developing and demonstrating thermal wave analysis as a non-destructive technique for the characterization of advanced ceramic materials. (1992)

**Dan A. Neumann**

for leadership in neutron research on key molecular scale properties of new layered materials for improved chemical processing and separation. (1991)

**David T. Read**

for developing a fracture mechanics approach to assessing the reliability of electronic packages. (1991)

**Richard E. Ricker**

for pioneering research on the corrosion and environment-induced cracking of advanced intermetallic alloys. (1991)

**Thomas A. Siewert**

for developing a materials research program that contributes to the quality, reliability, and safety of welded structures. (1991)

### **SPECIAL ACTS**

**James Kelly**

**James Kline**

**Lin-Sien Lum**

**Subhas Malghan**

**Dennis Minor**

**Patrick Pei**

Standard Reference Materials Program Special Service Award. (1993)

**Carol Handwerker**

for prompt and appropriate response in an emergency situation. (1992)

**Samuel Low**

**T. Robert Shives**

for Technology Administration logo contest prize. (1992)



## NIST AWARDS

### **WILLIAM P. SLICHTER (Building or strengthening ties between NIST and industry)**

<b>Francis Biancaniello</b>	for outstanding achievements as part of the industry/NIST SIGMA (supersonic inert-gas metal atomization) consortium, which have led to significant improvements in process efficiency and product quality. (1993)
<b>Paul Boyer</b>	
<b>Robert Parke</b>	
<b>Stephen Ridder</b>	
<b>H. Thomas Yolken</b>	

### **SAMUEL WESLEY STRATTON (Outstanding scientific or engineering achievements in support of NIST objectives)**

<b>J. Michael Rowe</b>	for their pioneering studies of the submicroscopic behavior of hydrogen isotopes in metals, which underlies a variety of critical technological issues ranging from hydrogen embrittlement to energy production. (1993)
<b>John Rush</b>	

### **SAFETY (Significant contributions to Safety Program)**

<b>Daniel Vigliotti</b>	for leadership of the safety program in the Materials Reliability Division. (1991)
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### **MEASUREMENT SERVICES (Achievement in calibration and measurement services)**

<b>Dominique Shepherd</b>	for successful implementation of the certification program for Charpy impact test machines. (1991)
<b>Thomas Siewert</b>	
<b>Daniel Vigliotti</b>	



# EXTERNAL RECOGNITION

1991-1993

**D.B. Anderson**

ASTM Committee E-49, Award of Appreciation (1992)

ASTM Committee E-49, Award of Recognition (1991)

ASTM Committee G-1, Certificate of Appreciation (1991)

Elected Chairman, ASTM Committee E-49.02, Data Recording Formats for Metals (1991)

**Joseph M. Antonucci**

Consultant to NIDR, Small Business Grants Study Section (1984-1991); Chairman (1992)

Member of Committee for Wilmer Souder Award (1992)

Recipient: Wilmer Souder Award of the International Association for Dental Research for outstanding research and contributions in the field of dental materials (1991)

Councilor: American Chemical Society (1991)

**George Birnbaum**

Associate Editor, Research in Nondestructive Evaluation (1993)

Chairman, Session on Metals Processing, ASNT Second Annual Research Symposium on NDE for Process Understanding, Sensing and Control (1993)

Editorial Board, Research in Nondestructive Evaluation, Associate Editor, Journal of Quantitative Spectroscopy and Radiative Transfer (1992)

Appointed to Chairman, Working Group on Intelligent Processing of Materials, Committee on Materials, White House, Office of Science and Technology Policy (1991)



- John W. Cahn** Cyril Stanley Smith Lecture - University of Chicago (1993)
- Inland Steel Lecture - Northwestern University (1993)
- William Hume-Rothery Award, TMS (1993)
- Michelson-Morley Award presented by Case Western University in recognition of pioneering work in materials science (1991)
- Craig Carter** Awarded the Ross Coffin Purdy Award by the American Ceramic Society (1991)
- A.V. Clark**  
**Christopher M. Fortunko**  
**M. Loz**  
**M.C. Renken**  
**S.R. Schaps** Award for outstanding paper, Journal of Nondestructive Evaluation (1992)
- A.V. Clark** Received an Award of Merit from the Federal Laboratory Consortium for Technology Transfer for his collaboration with Iowa State University on ultrasonic measurement of sheet steel formability (1992)
- Sam Coriell** Elected ASM International Fellow (1991)
- Aime DeReggi** Executive Committee member for Conference on Electrical Insulation and Dielectric Phenomena (CEIOP) (1992)
- Digest Editor for CEIOP (1992)
- James Early** Secretary of Versailles Project on Advanced Materials and Standards (VAMAS) (1992)
- Richard Fields** Cash award by Harry Diamond Laboratories, U.S. Army (1991)
- Christopher M. Fortunko** Appointed Fellow by Courtesy in the Department of Materials Science and Engineering at the Johns Hopkins University (1992, 1993)
- Anna C. Fraker** Elected ASM International Fellow (1993)

- Richard Gates**  
**Steven Hsu**      Received the Al Sonntag Award for most outstanding paper published by the Society of Tribologists and Lubrication Engineers (1991)
- Charles C. Han**      Advisory Board, Journal of Polymer Science, Physics Edition (1992)
- Executive Committee, Division of High Polymer Physics, American Physical Society (1992)
- Vice Chair, Polymer Physics, Gordon Conference, Newport, RI (1992)
- Carol A. Handwerker**      Elected a Fellow of the American Ceramic Society for outstanding contributions to ceramic science (1993)
- Donald L. Hunston**      Advisory Board, Composite Manufacturing (1992)
- Advisory Board, International Journal of Adhesion (1992)
- Executive Board, American Society for Composites (1992)
- Technical Advisory Board, Great Lakes Composites Consortium (1992)
- Technical Advisory Board, NSF-EPIC Center for Molecular and Microstructure of Composites (1992)
- Vice President, Adhesion Society (1992)
- David S. Lashmore**      American Electroplaters and Surface Finishers Research Award (1993)
- Blum Award: Electrochemical Society, Washington, DC Chapter (1993)

- Brian Lawn** Appointed Adjunct Professor, Carnegie Mellon University, Pittsburgh, PA (1993)
- Appointed Adjunct Professor, Lehigh University, Bethlehem, PA (1993)
- Appointed Adjunct Professor and Visiting Professor, Curtin University of Technology, Perth, Western Australia (1993)
- Associate Editor, Journal of the American Ceramic Society (1993)
- Brian Lawn**  
**Sheldon Wiederhorn** Presented the Hobart M. Kraner Award by Lehigh University (1991)
- Jeffrey W. Lynn** Elected to Fellowship in the American Physical Society (1993)
- R. Bruce Madigan**  
**Timothy P. Quinn**  
**Thomas A. Siewert** Poster Presentation, First Place Award, American Welding Society. Poster entitled, "Control of Arc Length During Gas Metal Arc Welding" (1993)
- Charles F. Majkrzak** Conference Chairman, Neutron Optics, SPIE, San Diego, CA (1992)
- Editor, SPIE Conference Proceedings, Volume 1738, Neutron Optical Devices and Applications (SPIE, Bellingham, WA) (1992)
- Chris N. McCowan**  
**Thomas A. Siewert** Poster Presentation, Second Place, International Metallographic Society. Poster entitled, "The Fracture of Type 316 Stainless Steel Welds" (1993)
- Poster Presentation, Second Place, International Metallographic Society (1993)

- Gregory McKenna** Editorial Review Board, Journal of Polymer Science, Physics Edition (1992)
- Chairman, Division of High Polymer Physics, American Physical Society (1992, 1991)
- Editorial Review Board, Journal of Rheology (1992, 1991)
- Committee Chairman, American Physical Society Prize in High Polymer Physics (1991)
- Visiting Scientist, Laboratoire d'Ultrasons et de Dynamique des Fluides Complexes, Universite Louis Pasteur, Strasbourg, France (1991)
- Leonard Mordfin** Charles W. Briggs Award of ASTM (1992)
- Jasper L. Mullen** Resource Education Awareness Partnership (REAP) (1992)
- Edward Prince** Co-Editor, Journal of Applied Crystallography (1992)
- Timothy P. Quinn** Received the Hetenyl Award from the Society for Experimental Mechanics for the Outstanding Paper in the Journal of Experimental Mechanics (1992)
- Tawfik M. Raby** ANSI/ANS Standards Committees:
- Chairman ANS-15.1 - "Technical Specifications for Research Reactors (1992)
- Chairman ANS-15.11 - "Radiation Protection at Research Reactor Facilities" (1992)
- Chairman ANS-15.4 - "Qualifications and Training of Operations Personnel at Research Reactors" (1992)
- Chairman N-17 - "Research Reactors, Reactor Physics, Radiation Shielding and Computational Methods" (1992)

- R.E. Ricker** Board of Review, Metallurgical Transactions (elected to Board 1992)
- Elected Vice-Chairman, Joint ASM/TMS Committee on Corrosion and Environmental Effects (1992)
- Elected Vice-Chairman, Unit Committee T-3E on SCC and Corrosion Fatigue, National Association of Corrosion Engineers (1992)
- National Science Foundation Evaluation Team for the University of Texas at El Paso Materials Research Center of Excellence (1991)
- U.S. Department of the Interior Bureau of Mines Intensive Research Area Review Committee (1991)
- Harry Rook** Chairman of Versailles Project on Advanced Materials and Standards (VAMAS) (1992)
- ASTM Award of Merit for distinguished service to the course of voluntary standardization (1991)
- Robert Roth** Selected to present the Sosman Award lecture at the Annual Meeting of the American Ceramic Society (1991)
- J. Michael Rowe** Fellow, American Physical Society (1993)
- APS Fellow, Division of Condensed Matter Physics (1992)
- Chairman, LANSCE Advisory Committee (1992)
- Chairman, Technical Review Committee, Condensed Matter Physics, Atomic Energy of Canada Limited (AECL) (1992)
- Distinguished Federal Executive Award (1992)
- Vice-Chairman, Basic Energy Sciences Advisory Committee (BESAC) (1991-92)



- John J. Rush** Co-Vice Chairman, DOE Basic Energy Sciences Advisory Committee, Panel on Neutron Sources (1992)
- Samuel J. Schneider** Appointed Chairman of ISO TC/206 on Fine Ceramics (1993)
- Elected Chairman ASTM Committee C28 on Advanced Ceramics (1992)
- Elected Chairman ASTM Committee C8 on Refractories (1992)
- Lyle H. Schwartz** Elected to Board of Trustees, ASM International (1991)
- Robert D. Shull** Appointed U.S. Chairman, Joint TMS/FEMS (Federation of European Metals Societies) symposia on advanced materials (1993)
- Elected Vice Chairman, TMS Chemistry and Physics of Materials Committee (1993)
- Special Guest Editor, Journal of Nanostructured Materials (1993)
- Elected Secretary/Treasurer, International Committee on Nanostructured Materials (1992)
- Thomas A. Siewert** Fellow, American Welding Society (1993)
- Certificate of Appreciation, American Society for Testing Materials, Committee E28, for contributions to impact testing standards (1992)
- Thomas A. Siewert**  
**Chris N. McCowan**  
**Daniel P. Vigliotti** Poster Presentation, Honorable Mention, American Welding Society. Poster entitled, "Verification of Charpy Impact Machine Performance" (1993)
- Thomas A. Siewert**  
**Mark W. Austin** Poster presentation, first place, American Welding Society. Poster entitled, "Monitoring Solder Joint Quality in Circuit Boards" (1992)

- Thomas A. Siewert**  
**R. Bruce Madigan**  
**Timothy P. Quinn**      Poster Presentation, Second Place, M.A. Morris Award, American Welding Society. Poster entitled, "Through the Arc Sensing for Control of GMAW" (1992)
- Jeffrey W. Stansbury**      Invited chapter to book on Expanding Monomers: Synthesis, Characterization and Applications (1991)
- C.P. Sturrock**      Elected Chairman, Working Party on Expert Systems in Materials Engineering, National Association of Corrosion Engineers, European Federation of Corrosion, and Materials Technology (1991)
- Lydon J. Swartzendruber**      Certificate of Appreciation, ASTM Committee E7 on Nondestructive Testing (1993)
- John A. Tesk**      Member, Interagency Oral Health Research Group (1992)
- Treasurer, Dental Materials Group of the International Association for Dental Research (1992, 1991)
- Editorial Review Boards: Dental Materials; and Oral Implantology (1991)
- Invited Lecturer to Forsyth Dental Center Conference; Industry/University/Government Research Alliances in the Public Interest: Models for the Future (1991)
- Invited Lecturer, Third International Kyoto Symposium on Biomedical Engineering, Kyoto, Japan (1991)
- Member, Executive Committee, Dental Materials Academy (1991)
- U.S. Expert for ANSI/ISO on Dental Porcelain-Metal Systems (1991)
- Visiting Professor, Tokushima University School of Dentistry, Tokushima, Japan (1991)

<b>Vinod K. Tewary</b>	Received the Pride of India Award from the Bochasanwasi Swaminarayan Sanstha for contributions in the field of computational materials science (1992)
<b>Ralph Tobler</b>	Received a doctoral degree from Tohoku University in Japan for his research and dissertation entitled "Fracture Mechanics at Liquid Helium Temperature: Property Measurements and Prestandards Research" (1992)
<b>David L. Vanderhart</b>	Elected Fellow, American Physical Society (1993)
<b>Sheldon Wiederhorn</b>	Elected to the National Academy of Engineering (1991)
<b>H. Thomas Yolken</b>	ASM - Heat Treatment Steering Panel (1993, 1992)  Co-Chairman, Second ASNT Research Symposium on NDE (1993)  Editor-in-Chief, Research in Nondestructive Evaluation (1993, 1992)  Executive Committee and Board of Directors, American Society for Nondestructive Evaluation (1993)  Program Committee, Eighth International Forum on New Materials, Italy (1993)  Board of Directors, American Society for Nondestructive Evaluation (1992)  Evaluation Panel, Lawrence Livermore Labs NDE Program (1992)  Principle Co-chairman for First ASNT Research Symposium on NDE (1992)  Review Panel (NSF) for MIT Manufacturing Center (1992)  Steering Committee, Sixth International Meeting on Materials Characterization (1992)

**H. Thomas Yolken  
(Cont.)**

Appointed to Chairman, Working Group on Intelligent Processing of Materials, Committee on Materials, White House, Office of Science and Technology Policy (1991)

Elected to the Board of Directors for the American Society for Nondestructive Testing (1991)

Elected Vice Chairman of the Research Council for the American Society for Nondestructive Testing (1991)

# **Technology Transfer**





# PARTNERS IN RESEARCH

## MSEL AGREEMENTS - FY 1993

<u>Active Agreements</u>	<u>FY 1991</u>	<u>FY 1992</u>	<u>FY 1993</u>
NIST	129	192	309
MSEL	27 (21%)	48 (25%)	100 (32%)
Industry	27	47	86
University	-----	1	13
Government	-----	-----	1
New MSEL Agreements	8	24	58

## MSEL PARTNERS\* Since 1988

	<u>Single Agreement</u>	<u>Multiple Agreements</u>	<u>Total</u>
Partners	64	19	83

### Multiple Agreement Partners\*\*

Aluminum Association, Inc. (2)	General Motors Corp. (8)
American Society for Testing and Materials (2)	Grumman Aerospace Corp. (2)
Aristech Chemical Corp. (2)	Minnesota Mining & Manufacturing Co. (3M) (3)
Armstrong World Industries, Inc (2)	National Association of Corrosion Engineers (4)
BDM, Inc. (2)	National Center for Manufacturing Sciences (2)
Crucible Metals Corp. (2)	Norton Co. (2)
Dentsply International, Inc. (2)	Raychem Corp. (2)
Dow Chemical Co. (3)	Rohm and Haas Co. (3)
E.I. du Pont de Nemours & Co. (4)	
Eaton Corp. (2)	
General Electric Co. (4)	

\* See Appendix B for a complete list of all MSEL CRADA Partners

\*\* Number in parenthesis indicates number of agreements since 1988

# STANDARDS COMMITTEES MEMBERSHIP

FY 1993

<u>MSEL Unit</u>	<u>Staff</u>	<u>Memberships</u>
Laboratory Office	4	12
Office of Intelligent Processing of Materials	----	-----
Ceramics	19	77
Materials Reliability	8	18
Polymers	9	32
Metallurgy	23	72
Reactor Radiation	<u>2</u>	<u>7</u>
	65*	218

\*Includes 40 leadership positions

## Representation

### Organization

American Chemical Society (ACS)  
American National Standards Institute (ANSI)  
American Nuclear Society (ANS)  
American Society of Mechanical Engineers (ASME)  
American Society for Testing and Materials (ASTM)  
American Society for Testing and Materials/Society of Automotive Engineers (ASTM/SAE)  
Department of Energy (DOE)  
Electronic Industries Association (EIA)  
European Thermophysical Properties Committee (ETPC)  
International Organization for Standardization (ISO)  
National Association of Corrosion Engineers (NACE)  
Safety Glazing Certification Council (SGCC)  
Technical Association of the Pulp and Paper Industry (TAPPI)  
Versailles Project on Advanced Materials and Standards (VAMAS)

# RESEARCH DISSEMINATION

FY 1993

UNIT	PAPERS PUBLISHED	TALKS INVITED	PATENTS*	SRMS*	MONOGRAPHS*
LABORATORY OFFICE	20	64	-----	-----	1
OFFICE OF INTELLIGENT PROCESSING OF MATERIALS	1	3	-----	-----	-----
CERAMICS	125	133	16	3	-----
MATERIALS RELIABILITY	82	15	4	4	-----
POLYMERS	175	74	8	-----	-----
METALLURGY	121	79	22	8	3
REACTOR RADIATION	<u>173</u> 697	<u>65</u> 433	<u>2</u> 52	<u>-----</u> 15	<u>1</u> 5

\* Described on following page.



# PATENTS

FY 1991-1993

GRANTED AND PENDING

## 1993 - Granted

Hard X-Ray Magnification Apparatus and Method with Submicrometer Spatial Resolution  
R. Spal (Ceramics), R. Dobbyn (Laboratory office), one other (non-NIST)  
Patent No. 5,259,013

Method of Producing a Smooth Plate of Diamond  
A. Feldman, E. Farabaugh (Ceramics)  
Patent No. 5,221,501

Neutron Absorbing Glass Compositions  
D. Blackburn, C. Stone, D. Cranmer, D. Kauffman, J. Grundl (Ceramics)  
Patent No. 5,221,646

Process for the Preparation of Fiber-Reinforced Ceramic Matrix Composites  
W. Haller (Ceramics), one other (non-NIST)  
Patent No. 5,187,008

Process for the Preparation of Fiber-Reinforced Ceramic Matrix Composites  
W. Haller (Ceramics), one other (non-NIST)  
Patent No. 5,221,563

Stable High Temperature Liquid Lubricant Blends and Antioxidant Additives for use  
Therewith  
J. Perez, C.S. Ku, S. Hsu (Ceramics)  
Patent No. 5,236,610

Sensing of Gas Metal Arc Welding Process Characteristics for Welding Process Control  
T. Siewert, R. Madigan, T. Quinn (Materials Reliability)  
Patent No. 5,221,825

Hydrofluoralkyl-Substituted Styrenes and Polymeric Compositions Containing Same  
C. Han (Polymers), four others (non-NIST)  
Patent No. 5,241,007

Heterophase Titanium Aluminides Having Orthorhombic and Omega-Type Microstructures  
L. Bedersky, W. Boettinger, F. Biancanello (Metallurgy)  
Patent No. 5,190,602



Materials Consolidation Modeling and Control System  
R.J. Fields (Metallurgy), 10 others (non-NIST)  
Patent No. 5,202,837

Metal-Coated Fiber Compositions Containing Alloy Barrier Layer  
N. Wheeler, D. Lashmore (Metallurgy)  
Patent No. 5,171,419

Predetermined Concentration Graded Alloys and Method for Production Thereof  
D. Lashmore, M. Dariel (Metallurgy)  
Patent No. 5,158,653

Apparatus and Methods for Identifying and Comparing Lattice Structures and Determining Lattice Structure Symmetries  
V. Karen, A. Mighell (Reactor Radiation)  
Patent No. 5,168,457

Apparatus and Methods for Identifying and Comparing Lattice Structures and Determining Lattice Structure Symmetries  
V. Karen, A. Mighell (Reactor Radiation)  
Patent No. 5,235,523

**1993 - Pending**

A Chemical Assisted Process for the Machining of Ceramics  
J. Wang, S. Hsu (Ceramics)  
Application No. NIST 92-016 (2/6/92)

A Cutting Fluid Additive for Abrasive Machining of Aluminum Oxide Ceramics  
S. Jahanmir (Ceramics)  
Application No. NIST 93-043 (3/18/93)

A Cutting Fluid Additive for Machining of Ceramics  
S. Jahanmir (Ceramics)  
Application No. NIST 93-020 (11/20/92)

A Process for the Molecular Chemical Preparation of Bismuth Telluride Composite Thermoelectric Refrigerants  
J. Ritter (Ceramics)  
Application No. 93-051 (5/24/93)

Method for Making Transparent Silicon Nitride at Low Temperatures Without Additives

A. Pechenik, G. Piermarini, S. Danforth (Ceramics)

Application No. NIST 92-027 (5/31/91)

PTO No. 973,751 (11/9/92)

Methods of Reducing Wear on Silicon Carbide Ceramic Surfaces

D. Deckman, S. Hsu (Ceramics)

Application No. NIST 92-002 (10/1/91)

PTO No. 883,313 (5/14/92)

Novel Method for Bonding Materials Together - Nanoglue

D. Smith, A. Grabbe, R. Horn (Ceramics)

Application No. NIST 93-003 (10/1/92)

PTO No. 08/005217 (1/21/93)

Oxygen-Containing Organic Compounds as Boundary Lubricants for Silicon Nitride Ceramics

R. Gates, S. Hsu (Ceramics)

Application No. NIST 92-036 (5/15/92)

Process for the Controlled Preparation of a Composite of Ultrafine Magnetic Particles

Homogeneously Dispersed in a Dielectric Matrix

J. Ritter, R. Shull (Ceramics)

Application No. NIST 89-030 (7/3/89)

PTO No. 501,981 (3/8/90)

Reactive Adsorption for High Green Density Ceramic Powders

S. Malghan (Ceramics)

Application No. NIST 93-026 (1/13/93)

Arc Length and Droplet Detachment Sensor System for Gas Metal Arc Welding

R.B. Madigan, T. Quinn, T. Siewert (Materials Reliability)

Application No. NIST 92-044 (7/7/92)

PTO No. 08/065393 (5/21/93)

Prevention of Contact Tube Melting to Arc Welding

T. Siewert, R.B. Madigan, T. Quinn (Materials Reliability)

Application No. NIST 93-057 (7/26/93)

Welding Electrode Composition for Cryogenic Service

T. Siewert, C. McCowan (Materials Reliability)

Application No. NIST 93-014 (11/12/92)

PTO No. 08/086531 (7/1/93)

Hydroxyfluoralkyl-Substituted Styrenes and Polymeric Compositions Containing Same  
C. Han, Y. Feng, M. He (Polymers)  
Application No. NIST 93-022 (2/27/91)  
PTO No. 985,932 (12/4/92)

Method for Detecting Polymer Solidification During Injection Molding  
A. Bur, F. Wang (Polymers), two others (non-NIST)  
Application No. NIST 90-031 (11/16/90)  
PTO No. 08/001728 (1/6/93)

Method for Detecting Resin Crystallization and Shrinkage During Polymer Injection Molding  
Based on Light Reflection  
A. Bur (Polymers), one other (non-NIST)  
Application No. NIST 93-061 (9/9/93)

Monomers for Double Ring-Opening Polymerization With Expansion  
J. Stansbury (Polymers)  
Application No. 90-030 (11/1/90)  
PTO No. 846,480 (3/6/92)

Novel Multifunctional Acrylates and the Synthesis Thereof  
J. Antonucci, J. Stansbury, G. Cheng (Polymers)  
Application No. NIST 90-026 (8/10/90)  
PTO No. 828,316 (1/30/92)

Polymeric Amorphous Calcium Phosphate Composites  
J. Antonucci (Polymers), two others (non-NIST)  
Application No. NIST 93-063 (9/16/93)

Synthesis of Hydrophobic, Low-Shrinkage Monomers and Oligomers for Composite, Sealant  
and Adhesive Applications  
J. Antonucci, J. Stansbury, D.W. Liu (Polymers)  
Application No. NIST 93-052 (5/24/93)

A Process for Producing Diamonds  
N. Wheeler, D. Lashmore, A. Shapiro (Metallurgy)  
Application No. NIST 90-003 (2/1/90)

Compton Scattering Tomography  
S. Norton (Metallurgy)  
Application No. NIST 92-050 (8/3/93)  
PTO No. 07/985115 (12/3/92)

Electroforming of Metallic Glasses for Dental Application  
D. Lashmore (Metallurgy), J. Tesk, M. Ratzker (Polymers)  
Application No. NIST 92-017 (2/9/92)  
PTO No. 08/019489 (2/19/93)

Fluidized Bed Coating of Powders  
D. Lashmore, D. Kelley (Metallurgy)  
Application No. NIST 93-033 (2/18/93)

Formation of Particulate and Laminar Composites Formed by Immersion  
D. Lashmore, C. Johnson (Metallurgy), two others (non-NIST)  
Application No. NIST 93-034 (2/18/93)

High Intermetallic Ti-Al-V-Cr Alloys Combining High Temperature Strength with Excellent Room Temperature Ductility  
L. Bendersky (Metallurgy)  
Application No. NIST 93-016 (11/11/92)  
PTO No. 08/093645 (7/20/93)

Intermetallic Titanium-Aluminum-Biogium-Chromium Alloys  
L. Bendersky (Metallurgy)  
Application No. NIST 93-001 (10/2/92)

Liquid Assisted Cold Welding of Powders Into Particulate Composites or Alloys  
M. Ratzker, A. Giuseppetti, D. Lashmore, C. Johnson (Metallurgy), one other (non-NIST)  
Application No. NIST 93-035 (2/18/93)

Method and Apparatus for Detecting Guided Leaky Waves in Acoustic Microscopy  
E. Drescher-Krasicka, J. Simmons (Metallurgy)  
Application No. NIST 92-030 (4/20/92)  
PTO No. 922,845 (7/31/92)

Nanocomposite Material for Magnetic Refrigeration and Superparamagnetic System Using the Same  
L. Bennett, R. Shull, L. Swartzendruber (Metallurgy)  
Application No. NIST 93-028 (5/31/89)  
PTO No. 08/010310 (1/28/93)

Novel Magnetic Materials Having Particular Utility for Magnetic Refrigeration  
R. McMichael, R. Shull (Metallurgy), J. Ritter (Ceramics)  
Application No. NIST 92-009 (12/19/91)  
PTO No. 875,413 (4/29/92)



Predetermined Concentration Graded Alloys and Method for Production Thereof

D. Lashmore, M. Dariel (Metallurgy)

Application No. NIST 86-008 (9/15/86)

PTO No. 721,090 (6/20/91)

Predetermined Concentration Graded Alloys and Method for Production Thereof

D. Lashmore, M. Dariel (Metallurgy)

Application No. NIST 93-004 (9/15/86)

PTO No. 977,781 (11/17/92)

Process for Electrodepositing Functional Chromium Coatings from an Aqueous Electrolyte

C. Johnson, D. Lashmore, E. Soltani (Metallurgy)

Application No. NIST 92-051 (8/5/92)

Process for Electrodepositing Metal and Metal Alloys on Tungsten, Molybdenum and other Difficult to Plate Metals

D. Lashmore, D. Kelley (Metallurgy)

Application No. NIST 94-002 (3/28/91)

Process for Electrodepositing Metal and Metal Alloys on Tungsten, Molybdenum and other Difficult to Plate Metals

D. Lashmore, D. Kelley (Metallurgy)

Application No. NIST 94-022 (3/28/91)

PTO No. 813,599 (12/26/91)

Process for Forming Alloys In-Situ in Absence of Liquid-Phase Sintering

D. Lashmore, M. Dariel (Metallurgy), J. Tesk (Polymers)

Application No. NIST 91-018 (8/19/91)

PTO No. 802,420 (12/4/91)

Process for Forming Alloys In-Situ in Absence of Liquid-Phase Sintering

D. Lashmore, M. Dariel (Metallurgy), J. Tesk (Polymers)

Application No. NIST 93-031 (8/19/91)

PTO No. 802,420 (12/4/91)

Visualization of Internal Stresses in Solid Non-Transparent Materials by Elastoacoustic Technique

E. Drescher-Krasicka (Metallurgy)

Application No. NIST 92-032 (5/13/92)

PTO No. 964,598 (10/29/92)

## **1992 - Granted**

A Method for Fabrication of Materials from Nano-Sized Particles Using High Pressure and Cryogenic Temperatures (c)

Patent No. 5,147,446

G. Piermarini, A. Pechenik (Ceramics)

Calibration Block and Method for an Ultrasonic System

Patent No. 5,163,027 - Assigned to Lockheed Corp.

J.T. Miller and B.W. Staff (Lockheed Corp); C.M. Fortunko (Materials Reliability)

Ultrasensitive Force Detector Employing Servo-Stabilized Tunnelling Junction

Patent No. 5,103,682

J.M. Moreland (Electromagnetic Technology Division); W.P. Dube (Materials Reliability)

Ultrasonic Image Sensing Array and Method

Patent No. 5,160,870 - Assigned to Inventors

P.L. Carson, A.L. Robinson, F.L. Terry, Jr. (University of Michigan); D.W. Fitting (Materials Reliability)

Dental Resins Comprising Cyclopolymerizable Monomers

Patent No. 5,145,374, issued September 8, 1992

J.W. Stansbury (Polymers)

Optical Sensor for the Measurement of Molecular Orientation and Viscosity of Polymeric Materials Based on Fluorescence Radiation

Patent No. 5,151,748, issued September 29, 1992

A.J. Bur, C.L. Thomas, R.E. Lowry, F.W. Wang, S.C. Roth (Polymers)

Nitrogenated Stainless Steel Via Gas Atomization

Patent No. 5,114,470, May 19, 1992

F.S. Biancaniello, G.M. Janowski, S.D. Ridder (Metallurgy)

## **1992 - Pending**

A Process to Lubricate Titanium with Chlorinated Hydrocarbons

J. Wang, S.M. Hsu (Ceramics)

A Process to Machine Titanium Using Chlorinated Hydrocarbons

J. Wang, S.M. Hsu (Ceramics)

A Super Stable High-Temperature Liquid Lubricant Containing a Unique Antioxidant and Additive Solubilizing Ternary System

J. Perez, C. Ku, Y.M. Zhang (Ceramics)



Coprecipitation Synthesis of Precursors to Mismuth-Containing Superconductors

Patent No. 5,077,265

J. Ritter (Ceramics)

Detergent and Dispersant Type Organic Compounds as Boundary Lubricants for Silicon Nitride Ceramics

R.S. Gates, S.M. Hsu (Ceramics)

Hydroxyl Containing Organic Compounds as Boundary Lubricants for Silicon Nitride Ceramics

R.S. Gates, S.M. Hsu (Ceramics)

Methods of Reducing Wear on SiC Ceramic Surfaces

D.E. Deckman, S.M. Hsu (Ceramics)

Methods of Determining Loads and Fiber Orientations in Anisotropic Non-Crystalline Materials Using Energy Flux Deviation

Applied for by NASA

W.H. Prosser (NASA-Langley), R.D. Kriz (Virginia Polytech Institute), D.W. Fitting (Materials Reliability)

Thermal Properties Measurement Using a Superconductor Sensor

Applied for

W.P. Dube (Materials Reliability); L.F. Goodrich, J.M. Moreland (Electromagnetic Technology Division)

Functional Trivalent Chromium

Disclosure filed

C. Johnson, D. Lashmore, E. Soltani (Metallurgy)

Intermetallic Titanium - Aluminum - Niobium Alloys Based on Strengthening of the Orthohombic Phase by Omega-Type Phase

Applied for

L.A. Bendersky, W.J. Boettinger, F.S. Biancaniello (Metallurgy)

Low Temperature Consolidation of Ag<sub>3</sub>Sn Intermetallics

Patent Pending

D. Lashmore, M.P. Dariel, E. Escalante (Metallurgy), J.A. Tesk (Polymers)

Material Consolidation Modeling and Control System

Applied for

R.J. Fields (Metallurgy), 10 others (non-NIST)

### **1991 - Granted**

A Colloidal Processing Method for Coating Ceramic Reinforcing Agents

Patent No. 5,039,550

S. Malghan, C. Ostertag (Ceramics)

Process for the Fabrication of Ceramic Monoliths

(By Laser Assisted Chemical Vapor Deposition)

Patent No. 5,001,001

J. Ritter (Ceramics)

Thermal Technique for Determining Interface and/or Interply Strength in Composites

Patent No. 4,972,720

W. Wu (Polymers)

### **1991 - Pending**

A Method for Making Translucent High Purity Silicon Nitride

A. Pechenik, G. Piermarini, S. Block, S. Danforth (Ceramics)

Diamond Coated Laminates and Methods of Producing Same

A. Feldman, E.N. Farabaugh (Ceramics)

High Resolution X-Ray Microtomographic Detector

R.D. Spal, M. Kuriyama, R.C. Dobbyn (Ceramics)

2-Dimension Image Quality Indicator for Radioscopy

Disclosure Filed

T.A. Siewert, M.W. Austin (Materials Reliability) and G.K. Lucey, J. Adams (Harry Diamond Labs)

Air Drying Resins and Processes for Preparing Same

Disclosure Filed

B. Dickens, B.J. Bauer (Polymers)

Dental Monomer/Resin Systems Based on Vinyl Metalloxy-carboxylates

Applied For

J.M. Antonucci, J.W. Stansbury, B.O. Fowler (Polymers)

Novel Fluorinated and Siloxane Multifunctional Acrylates and the Synthesis Thereof

Applied For

J.M. Antonucci, Guo Wei Cheng (Polymers)

Radiation Curable Resins Based on Hydroxy Acrylates and Acid Dianhydrides

Disclosure Filed

B. Dickens, B.J. Bauer (Polymers)

Radiation Curable Resins Based on Polyethylene Glycol Acrylates and Poly Isocyanates

Disclosure Filed

B. Dickens, B.J. Bauer (Polymers)

A Process for Electroplating Metal and Alloys on Cu-W and Other Difficult to Plate Materials

Applied For

D. Lashmore, D. Kelley (Metallurgy)

A Process for Producing Diamonds

Applied For

N. Wheeler, D. Lashmore, A. Shapiro (Metallurgy)

Acoustic Emission Energy Calibration Device

Disclosure Filed

R. Clough, R. Patel (Metallurgy); E. Ives (Shops)

Nitrogenated Metal Alloys via Gas Atomization

Applied For

F.S. Biancaniello, G.M. Janowski, S. Ridder (Metallurgy)

# STANDARD REFERENCE MATERIALS

FY 1993

## Ceramics

SRM 1004a Calibrated Glass Beads

SRM 1978 Particle Size Distribution for Gravity Separation

SRM 10036 Calibrated Glass Beads

## Materials Reliability

SRM 1842 X-Ray Stage Calibration Board

SRM 2092, 2096, 2098 Charpy V-Notch Certification Specimens

## Metallurgy

SRM 1357, 1358, 1359, 1360, 1363a, 1364a Chrome on Copper on Steel (Coating Thickness)

SRM 1906 Nickel Microhardness Standard

SRM 2798 New 500 g Vickers Microhardness

# MONOGRAPHS

FY 1993

Fracture of Brittle Solids  
Cambridge University Press  
Second Edition, 1993  
B.R. Lawn (Laboratory Office)

Electrochemistry in Materials Synthesis and Surface Modification  
Critical Reviews in Surface Chemistry, August 1993  
T.P. Moffat (Metallurgy), 1 other (non-NIST)

Pitting Corrosion of Aluminum-Manganese Alloys, Corrosion, Electrochemistry, and  
Catalysis of Metastable Metals and Intermetallics, eds. K. Hashimoto and C.R. Clayton  
The Electrochemical Society, Pennington, NJ, 1993  
T.P. Moffat, G.R. Stafford, D.E. Hall (Metallurgy)

Magnetic Multilayers  
World Scientific Publishing Co. 1993  
L.H. Bennett (Metallurgy), 1 other (non-NIST), editors

NIST Cold Neutron Research Facility  
Journal of Research of NIST, Special Issue, Vol. 98, No. 1, Jan-Feb 1993, pp. 1-144  
J.M. Rowe (Reactor Radiation)

# CONFERENCE PROGRAM

(SPONSOR OR CO-SPONSOR)

FY 1991-1993

## 1993

### Conference on Commercialization of Advanced Joining Technology

September 27-28, 1993 (H. McHenry-Materials Reliability)

60 attendees

Sponsored by NIST in cooperation with the American Welding Society, Sandia and the Idaho National Engineering Laboratory. Described the joining technology being developed by NIST, the Department of Energy, and the U.S. Navy and identified the technology transfer mechanisms that enable industry to use it.

### Workshop on Fluid Flow in Liquid Composite Molding

September 20-22, 1993 (R. Parnas-Polymers and General Electric and Ford Motor Company)

41 attendees

Jointly sponsored workshop between NIST, General Electric, and Ford Motor Company and attended by industry scientists and university researchers to clarify the fluid flow issues facing industry.

### 12th International Corrosion Congress, International Corrosion Council, NACE International

September 19-24, 1993 (R.E. Ricker-Metallurgy, International Corrosion Council and NACE International)

1200 attendees

The 12th International Corrosion Congress brought together corrosion scientists from all over the world to attend more than 30 technical sessions on different topics where more than 400 technical papers were presented.

### ASTM Symposium on Materials Databases

September 1993 (E. Begley and C. Sturrock-Ceramics and ASTM)

80 attendees

An international review of materials databases and their application.



Workshop on Crystallographic Databases for Chemical and Materials Analysis

August 26, 1993 (A.D. Mighell-Reactor Radiation and W. Wong-Ng-Ceramics and XVI Congress and General Assembly of the International Union of Crystallography, China)  
41 attendees

A workshop to teach attendees how to use NIST databases (i.e., NIST Crystal Data and the Electron Diffraction Database) to solve research and analytical problems.

International Conference on Machining of Advanced Materials

July 21-22, 1993 (S. Jahanmir-Ceramics and NSF)  
175 attendees

A conference to review the state of the art of machining advanced materials and to identify fundamental research issues.

Acoustic Propagation in Anisotropic Periodically Multilayered Media, Floquet Waves Permit to Solve Numerical Instabilities

July 27, 1993 (G. Birnbaum-OIPM and J.F. de Belleval - Universite' de Technologie de Compiègne, France)  
25 attendees

A seminar that dealt with the theory of propagation of acoustic waves through thick stratified composite materials.

Surgical Applications of Calcium Phosphate Cement

May 14, 1993 (J. Tesk-Polymers and W. Marjenhoff-American Dental Association Health Foundation Paffenbarger Research Center)  
90 attendees

Workshop for medical media and surgeons to describe animal trials and human clinical trials of surgical applications of a NIST-developed material, calcium phosphate cement.

International Conference on Extreme Theory and Its Applications

May 2-7, 1993 (R.E. Ricker-Metallurgy and Temple University)  
150 attendees

A conference to discuss Extreme Value statistics and its applications including five sessions on applications in materials science and engineering.

NIST Workshop on Metal Coated Continuous Strip

April 29, 1993 (E.C. Soltani-Metallurgy, AISI, and ASTM Committee B8, Metallic and Inorganic Coatings)

45 attendees

Workshop to identify the electrogalvanizing industry's concerns relating to standards and measurement methods for: (1) coating characterization, (2) determining process capability and (3) predicting coating performance; and to establish a basis for cooperation between industry and NIST to systematically address these concerns.

NIST/Polymers Division SAXS Users' Workshop

April 19-20, 1993 (J. Barnes-Polymers)

30 attendees

Workshop to acquaint industrial and academic users of NIST's Digital Small Angle X-Ray Scattering (SAXS) Facility.

Adaptive Mesh Refinement for Solidification Problems

April 2, 1993 (H.T. Yolken-OIPM and N. Palle-University of Illinois)

Seminar to discuss advances in adaptive mesh refinement.

Corrosion of Advanced Materials

March 10, 1993 (R.E. Ricker-Metallurgy and National Association of Corrosion Engineers [now NACE International])

80 attendees

One of six sessions as part of the 1993 Corrosion Research in Progress Symposium for discussion of the latest trends and significant findings in corrosion research and the development of corrosion resistant advanced materials.

First Joint TMS/FEMS Symposium on Nanocrystalline Materials

February 25, 1993 (R.D. Shull-Metallurgy)

100 attendees

A five day symposium on the status of the field of nanocrystalline materials in the U.S. and Europe. Written by the Journal of Metals as the highlight of the TMS Annual Meeting in February 1993.

Workshop on Characterizing Diamond Films II

February 24-25, 1993 (A. Feldman-Ceramics)

65 attendees

A workshop to provide an update on characterization technique development.

Workshop on Crystallographic Databases for Chemical and Materials Analysis  
December 4, 1993 (W. Wong-Ng-Ceramics, A. D. Mighell-Reactor Radiation, and The  
Materials Research Society)  
10 attendees

To instruct attendees on the use of NIST Crystallographic Databases to solve research problems in materials sciences.

Conference on Passport Laminate Testing  
October 9, 1992 (W. McDonough-Polymers and U.S. Department of State)  
26 attendees

A jointly sponsored workshop to discuss test methods currently used to evaluate the laminating materials that the government employs to protect data on passports and other such documents.

## 1992

Symposium on Process Simulation in Liquid Molding  
September 30-October 3, 1992 (F. Phelan-Polymers)  
40 attendees

To bring together the top experts in process simulation modelling for liquid molding to exchange ideas and discuss the current state-of-the-art and the challenges for the future.

Joint OIPM/Metallurgy Seminar on Modeling of Diffusional Mechanisms of Creep and Sintering  
September 24, 1992 (H.T. Yolken-OIPM and E. Drescher-Krasicka-Metallurgy)  
20 attendees

To describe a variational principle for grain-boundary diffusion processes.

Lubrication Technologies for Future Energy Conversion Systems  
September 21-23, 1992 (S.M. Hsu-Ceramics)  
44 attendees

To identify current and future research needs as well as to prioritize future activities.

Joint OIPM and Automated Production Technology Seminar on Ultrasonic Evaluation of Interfacial Properties in a Layered Substrate

September 16, 1992 (H.T. Yolken-OIPM and G. Blessing-Automated Production Technology Division)

15 attendees

The results of experimental work and numerical calculations were presented on the interfacial properties in the layered substrate that were critical to the performance of the materials and the interface might be evaluated by utilizing a turning point in the lowest lamb mode.

NIST Cold Neutron Research Facility Researchers' Group Meeting

August 28, 1992 (W. Kamitakahara, C. Glinka-Reactor Radiation)

50 attendees

To review recent work at the CNRF, discuss procedures and future plans.

Workshop on Photonic Materials

August 26-28, 1992 (J.A. Carpenter and S.W. Freiman-Ceramics, organized in cooperation with the OIDA)

87 attendees

To identify material issues of importance to photonic systems.

ACS Symposium "Neutron Scattering from Polymers"

August 25-27, 1992 (C. Han-Polymers, B. Hammouda-Reactor Radiation)

80 attendees

To acquaint polymer scientists with neutron techniques for the characterization of polymers.

NASA, Navy, NIST Program Review on Advanced Resin Transfer Molding

August 13, 1992 (D. Hunston-Polymers)

15 attendees

To exchange information between the three major government programs in the area of composite fabrication by resin transfer molding.

Conference Diamond Optics IV at 35th Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering

July 20-21, 1992 (A. Feldman-Ceramics)

30 attendees

Conference to review the status of the use of diamond for optics.



Workshop on Thermal Spray Research

July 20, 1992 (S.J. Dapkunas-Ceramics)

40 attendees

To identify research issues critical to the reproducibility and performance prediction of thermal spray coatings.

Workshop on Intelligent Processing of Ceramic Powders

July 17-18, 1992 (S.G. Malghan-Ceramics)

40 attendees

To determine measurement research needs for process control.

Johnson Conference - 1992 - Asbestos: Measurement, Risk Assessment, and Laboratory Accreditation

July 12-17, 1992 (H.L. Rook-MSEL)

Sponsored by ASTM

200 attendees

Workshop on Coatings Technology

June 23, 1992 (H.T. Yolken-OIPM and J. Frohnsdorff-Building and Fire Research Laboratory)

12 attendees

Second Industrial workshop to plan the Coating Technology Consortium.

OIPM Seminar on Generation and Detection of Ultrasound by Laser and Its Application

June 18, 1992 (G. Birnbaum-OIPM)

20 attendees

To give an overview of the physics of laser ultrasonics (both generation and detection) and its application and to discuss its limitations due to engineering constraints.

Workshop on Intelligent Processing of Ceramic Slurries

June 15-16, 1992 (H.T. Yolken-OIPM and S.W. Freiman-Ceramics)

14 attendees

Industrial workshop to plan a consortium on Ceramic Processing.

NIST/Industry Workshop on "Aging, Dimensional Stability and Durability Issues in High Technology Polymers"

May 28-29, 1992 (G.B. McKenna-Polymers)

45 attendees representing 16 different companies

To discuss issues of aging, dimensional stability and durability in polymers that affect industries ranging from automotive, civilian aircraft and electronic packaging and electronic imaging.

NIST/JCPDS/IUC: Accuracy in Powder Diffraction II Conference

May 26-29, 1992 (E. Prince, J. Stalick-Reactor Radiation)

175 attendees

To assess progress in theory, techniques, and applications of powder diffraction since APD I in 1979.

3rd Industry Workshop on Polymer Composite Processing

May 21-22, 1992 (D.L. Hunston-Polymers)

45 attendees

To transfer technology developed in NIST's composite processing program to industry and obtain guidance from industry for planning future program directions.

Workshop on Mechanical Test Methods for Particulate-Reinforced MMC

May 20, 1992 (L. Mordfin-Metallurgy)

12 attendees

To explore ways to address needs for mechanical test methods for metal-matrix composite materials.

Workshop "Advances in EXAFS Application"

May 18, 1992 (C. Bouldin-Ceramics)

20 attendees

A workshop to identify opportunities in extended x-ray adsorption fine structure (EXAFS).

Workshop on "Small-angle X-ray Scattering for Materials Science"

May 18, 1992 (G. Long-Ceramics)

20 attendees

A workshop to identify opportunities in small angle x-ray scattering (SAXS).



First NIST Workshop on Nanostructured Materials

May 14-15, 1992 (R.D. Shull-Metallurgy)

50 attendees

To review the state-of-the-art of nanostructured materials, identify potential application areas, and determine future research directions.

Workshop on Casting of Aerospace Alloys

April 28, 1992 (H.T. Yolken-OIPM and Aerospace Industries Association)

43 attendees

Second Industrial Workshop to plan the Casting of Aerospace Alloys Consortium.

Workshop on Intelligent Processing of Polymer Blends

April 20-21, 1992 (H.T. Yolken-OIPM and C. Han-Polymers)

55 attendees

Industrial workshop to plan a consortium on Polymer Blends.

NIST/Industry Workshop on "Polymer Blends"

April 20-21, 1992 (C. Han-Polymers)

49 attendees

To discuss current knowledge base in phase behavior on polymer blends, future needs and formation of industrial consortium to work with NIST on critical issues in polymer blends technology.

Symposium on Smart Materials

April 13-14, 1992 (G. White-Ceramics)

30 attendees

Sponsored by American Ceramic Society to review status of ceramics in "Smart Materials".

Workshop on Characterizing Diamond Films

February 27-28, 1992 (A. Feldman-Ceramics)

25 attendees

A NIST-sponsored workshop for U.S. companies covering in depth issues related to applications of diamond and the need for standards.

Workshop on Coatings Technology

February 19-20, 1992 (H.T. Yolken-OIPM and J. Frohnsdorf-Building and Fire Research Laboratory)  
19 attendees

Industrial workshop to plan the Coating Technology Consortium.

Symposium in Honor of Adhesion Society's Award of Excellence Winner

February 17-19, 1992 (D. Hunston-Polymers)  
175 attendees

To honor the contributions of Dr. A.J. Kinloch who is the recipient of the Adhesion Society's 1992 Award for Excellence in Adhesion Science.

Workshop on Casting of Aerospace Alloys

January 16, 1992 (H.T. Yolken-OIPM and Aerospace Industries Association)  
30 attendees

Industrial Workshop to plan the Casting of Aerospace Alloys Consortium.

OIPM Seminar on Investigation of Ultrasonic Plane Wave Scattering by a Randomly Rough Solid State Interface

November 4, 1991 (H.T. Yolken-OIPM)  
30 attendees

To provide a theoretical basis for supporting surface roughness effects from internal or intrinsic properties of materials.

Environmental Effects on Advanced Materials

October 7-9, 1991 TMS/ASM Symposium (R.E. Ricker-Metallurgy and R.H. Jones-Battelle)  
150 attendees

To discuss status of research into environmental degradation of advanced materials.

**1991**

High Resolution Diffraction Imaging of Space Related Crystal: The Second Generation

September 9, 1991 (B. Steiner-Ceramics)  
20 attendees

To review research results and identify future materials investigations.

American Chemical Society Symposium of Flow-Induced Structural Changes in Polymers  
August 28-29, 1991 (A.I. Nakatani-Polymers)  
50 attendees

Special Symposium of the ACS Division of Polymeric Materials Science and Engineering.

Joint American Physical Society-American Chemical Society Symposium on "Thermoreversible Gelation in Polymers"  
August 1991 (G.B. McKenna-Polymers)  
80 attendees

International symposium on gelation in polymers.

Application of Diamond Films and Related Materials, ADC91  
August 20-22, 1991 (A. Feldman-Ceramics)  
50 attendees

To review applications of the new diamond technology.

Workshop on the Crystallographic Database for Chemical and Material Analyses  
August 7, 1991 (A. Mighell-Reactor Radiation, and W. Wong-Ng-Ceramics)  
40 attendees

In conjunction with Pacific-International Congress on X-ray Analytical Methods; to acquaint potential users with utility of crystallographic database for chemical and material analysis applications.

Symposium on Diamond Options IC at 35th Annual International Technical Symposium on Optical and Optoelectronics  
July 21-26, 1991 (A. Feldman-Ceramics)  
400 attendees

To review applications of diamonds to optics.

Joint OIPM/Metallurgy Seminar on Ultrasonic Guided Waves in Fluid-Loaded Plates with Application to NDE of Composites  
July 11, 1991 (H.T. Yolken, OIPM and R. Clough-Metallurgy)  
20 attendees

To review guided wave propagation in fluid-loaded plates.

Joint Services Technical Coordinating Group on Nondestructive Testing and Inspection,  
Subgroup on Specifications and Standards

July 11, 1991 (L. Mordfin-Metallurgy)  
10 attendees

To coordinate NDT standards development activities in the DOD agencies and NIST.

CNRF Researchers' Group Meeting

June 6, 1991 (W. Kamitakahara-Reactor Radiation)  
70 attendees

To acquaint potential CNRF researchers with capabilities and procedures relating to utilization of the National Facility.

Workshop on Applications of Cold Neutron Spectroscopy in Chemistry, Biology, and Physics

June 4-5, 1991 (W. Kamitakahara-Reactor Radiation)  
150 attendees

To explore some of the exciting new opportunities which will be made available to U.S. researchers when six new high-resolution inelastic scattering spectrometers are completed at the CNRF.

Microanalysis of Electronics

May 29-30, 1991 (J. Carpenter-Ceramics)  
30 attendees

Short course co-sponsored with ASM International to review microscale analysis of electronics.

NIST/Univ. of Minnesota Center for Interfacial Engineering Workshop on Cold Neutron Techniques

May 6-8, 1991 (F. Bates-Univ. of Minn. and C. Glinka-Reactor Radiation)  
20 attendees

To familiarize researchers of the Center for Interfacial Research affiliate companies with neutron techniques for interfacial applications.

Ceramics Bearing Technology Workshop

April 17-18, 1991 (S. Jahanmir-Ceramics)  
100 attendees

To review the state-of-the-art in ceramic bearing technology and recommend future research directions.



ASTM Symposium on Nondestructive Testing Standards

April 4-11, 1991 (L. Mordfin-ONDE)

200 attendees

To review the status and future directions for NDT Standards, and discuss their role in the market places of the future.

NIST Workshop in Small Angle X-Ray Scattering

April 3, 1991 (J.D. Barnes and E.S. Clark-Polymers)

15 attendees

To review status and future prospects for the NIST 10 Meter Digital SAXS Camera facility with users and potential users.

Seminar on R&D Activities in Ultrasonics and Acoustic Emission in Japan

February 26, 1991 (G. Birnbaum-OIPM)

10 attendees

A report on the research and development activities of ultrasonics and acoustic emission in various Japanese laboratories.

Seminar on the Role of Mathematical Modeling in the Intelligent Processing of Materials

February 15, 1991 (H.T. Yolken-OIPM)

35 attendees

To discuss the methodology of mathematical model development and the relationship of models to experimental work.

NASA Microgravity Sciences Diffraction Imaging Program

February 5, 1991 (B. Steiner-Ceramics)

25 attendees

To review program results and develop future directions.

Conference on Development of Advanced Materials - Current Issues and Prospects

December 17-19, 1990 (S. Wiederhorn-Laboratory Office)

50 attendees

Fundamentals of Carbon/Carbon

December 6-7, 1990 (D. Cranmer-Ceramics)

30 attendees

To review state-of-the-art and future directions of carbon/carbon composites for structural applications.

Workshop on New Measurements for Polymer Processing

December 3-4, 1990 (A.J. Bur-Polymers)

20 participants

To define real-time measurement needs of the polymer processing industry and to establish a NIST/industry research consortium.

Joint OIPM/Metallurgy Seminar on Advanced Sensors for Process Monitoring and Control of Polymer Composites

November 20, 1990 (H.T. Yolken-OIPM and E. Drescher-Krasicka, Metallurgy)

20 attendees

To discuss techniques for monitoring materials microstructure during the processing of carbon fiber reinforced epoxy/phenolic matrix composites.

Environmental Effects on Advanced Materials

October 7-11, 1990 (R.E. Ricker-Metallurgy)

65 attendees

To promote the development of advanced materials by presenting and discussing research into the mechanisms for prevention of degradation of these materials by the service environment.

Seminar on Laser Ultrasonic and Magnetic Sensors for Monitoring Materials

October 4, 1990 (H.T. Yolken-OIPM)

25 attendees

To review recent advances in the application of firstly laser ultrasonic and secondly magnetic sensing methods to engineering materials.

4th U.S./Japan Workshop on Low Temperature Structural Materials and Standards

October 1-2, 1990 (H. McHenry-Materials Reliability), Vail, CO

25 attendees

Recent research on alloys and composites to be used in 4-K superconducting magnets for fusion energy devices was reported at the workshop.





# Appendices



## 1993 PANEL MEMBERS

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# COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS MSEL

FY 1988 - FY 1993

## PARTNER\*

## SUBJECT

### Materials Science and Engineering Laboratory

General Motors Corporation,  
Allison Turbine Division

Stress and Creep Rupture Behavior of  
HIP'ed Silicon Nitride Material

Nanophase Technologies  
Corporation

Processing of Ceramic Powders

### Office of Intelligent Processing of Materials

#### Consortia

Allied-Signal Corporation  
American Foundrymen's Society  
Auburn University  
Case Western Reserve University  
EG&G Idaho, Inc.  
General Motors Corporation,  
Allison Turbine Division  
Howmet Corporation  
Massachusetts Institute of  
Technology  
Pennsylvania State University  
Purdue University  
UES, Inc.  
United States Department of  
the Interior  
University of Alabama  
University of Arizona  
Worcester Polytechnic Institute

Consortium on Modeling of Casting of Aerospace  
Metal Alloys



**PARTNER\*****SUBJECT**

Cercom, Inc.  
Eaton Corporation

Intelligent Processing of Ceramic Powders  
Consortium

Aristech Chemical Corporation  
Armstrong World Industries, Inc.  
Minnesota Mining and Manufacturing  
Company, 3M (2)  
Raychem Corporation (2)  
Rohm and Haas Company

Polymer Blends Consortium

Dow Chemical Company  
du Pont  
Flow Vision, Inc.  
Minnesota Mining and Manufacturing  
Company, 3M  
Rohm and Haas Company

Polymer Processing Consortium

Crucible Materials Corporation,  
Crucible Compaction Metals Division  
Metallurgy, Inc.  
United Technologies, Pratt &  
Whitney Division

Powdered Metal Consortium

**Single Agreements**

General Motors Corporation,  
Saginaw Division

Case-Depth Determination in Steel Shafts

**Ceramics****Consortia**

Ceradyne Inc.  
Cincinnati Milacron, Inc.  
Corning Incorporated  
Dow Chemical Company  
Eaton Corporation  
Ford Motor Company  
General Electric Company  
General Motors Corporation,  
AC Rochester Division

Ceramics Machining Consortium

**PARTNER\*****SUBJECT**

Norton Company  
SAC International  
Sonoscan, Inc.  
Stevens Institute of Technology  
Texas A&M University  
Therm Advanced Ceramics  
Tower Oil and Technology Company  
University of Maryland  
W.R. Grace & Co.

Ceramics Machining Consortium (Cont.)

**Single Agreements**

Akzo America, Inc.

Lubricants

American Society for Testing  
and Materials (2)

SRM's for Glass, Glass Ceramics and  
Related Products

Carborundum Company, Inc.

Tribological Characterization of Ceramics

du Pont

Mechanical Properties of Alumina Ceramics

General Motors Corporation,  
Delco Products Division

Characterization and Deagglomeration of  
Strontium Ferrite Magnet Slurry

Norton Company

Comparative Milling of Silicon Nitride  
Powder in Agitation and Vibratory Mills

Trans-Tech, Inc.

Magnetic Film Development

**Materials Reliability****Consortia**

Bechtel National  
General Atomics  
General Dynamics

Superconducting Magnetic Energy  
Storage (SMES) Composite Testing

**Single Agreements**

Composite Technology  
Development, Inc.

Composite Research and Development

**PARTNER\*****SUBJECT**

General Motors Corporation  
AC Rochester Division (2)

Through the Arc Sensing of Gas  
Metal Arc Welding

RITEC, Inc.

Innovative Ultrasonic Instrumentation and Testing  
Techniques

Southwest Research Institute

Gas-Coupled Ultrasonic Inspection  
Technology

**Polymers****Single Agreements**

Air Techniques, Inc.

Science of Gas Plasma Sterilization

American Dental Association  
Health Foundation

Research in Dental and Medical Materials

Aristech Chemical Corporation

Polymer Blends

Armstrong World Industries, Inc.

Viscoelastic Properties of Polymer Materials

Automotive Composites  
Consortium

Flow Simulations

Dentsply, International

Hydrophobic Dental Composite Filling  
Materials

Dow Chemical Company

Incubation Process for Fracture of Engineering  
Thermoplastics

du Pont

Polymer/Solid Interface Structure

Chem. & Phys. Performance of Methacrylate  
Macromonomers

Eastman Kodak Company

Small Angle Neutron Scattering

Elf Acquitaine, Inc.

Structure Formation and Mechanical  
Characterization of Copolymer Blends

<b>PARTNER*</b>	<b>SUBJECT</b>
Eni Chem America, Inc.	Cure Monitoring of Resins by Fluorescence Spectroscopy
Exxon Research and Engineering Company	Small Angle Neutron Scattering in Polyolefin Blends
Fusion Systems	Gas Plasma Sterilization
General Electric	Transient Flow Phenomena in RTM Composite Preforms
Goodyear Tire & Rubber Company	Interaction Parameters of PI/PBD Blends
Grumman Aerospace Corporation	Testing of Process Simulation Model for Resin Transfer Molding  Resin Transfer Molding of Precursor Resins for Ceramic Matrix Composites
International Business Machines Corporation	Polymers
Michigan Molecular Institute	Small Angle Neutron Scattering Study
National Center for Manufacturing Sciences, Inc.	Comprehensive State-of-the-Art Search in Polymers
Rheology Research	Mechanical Properties of Polymeric Materials
Rohm and Haas Company	Polymeric Microstructure
Technical Assessment Systems, Inc.	Microbial Toxicity Testing
Union Carbide Corporation	Improved Performance of Polymeric Power Cable Insulation
University of Delaware	Physical Aging and Fatigue of Semi-crystalline Polymers
ViGYAN, Inc.	Liquid Molding Process Simulator

**PARTNER\*****SUBJECT****Metallurgy****Consortia**

SPS Laboratories  
Nuclear Metals, Inc.

New Permanent Magnet Materials

Xerox Corporation  
Cornell University

Magnetic Nanocomposites as Powders,  
Coatings, Thin Films, and Monolithic Structures

**Single Agreements**

Aluminum Association, Inc.

Measurements of Temperatures of  
Aluminum Products

Non-contact Temperature Measurement

American Iron and Steel Institute

On-Line, Non-Destructive Mechanical Properties  
Measures & Microstructure Engineering in Hot  
Strip Mills

BDM Corporation (2)

Intelligent Control of Hot Isotatic Pressing

Beane, Alan and Glenn

Particulates Composites

Crucible Materials Corporation,  
Crucible Compaction Metals Division

Nitrogen Additions to Corrosion Resistant  
Metals

Dentsply International, Inc.

Consortium for Development of Advanced  
Restorative Alloys

du Pont

Thin Film Process Development of High  
Temperature Superconducting and Dielectric  
Materials

Fluoramics, Inc.

Development of Practical Superconducting  
Devices

Fluxtrol Manufacturing, Inc.

Materials Development and Fabrication  
Techniques for Magnetic Concentrators

GMW Associates

Testing of Iron Core Magnets

**PARTNER\*****SUBJECT**

General Electric Company	Development of Scanning Ultrasonic Microscope (SAM) Techniques
General Motors Research Laboratories	Magnetocaloric Properties of Nanocomposite Materials
George Washington University	Modelling of the Noise Characteristics of Magnetic Recording Heads
M & T Harshaw	Electrochemistry of Trivalent Chromium (Cr III) Solutions
Materials Innovation, Inc.	Investigation of the Feasibility of Electroplating Nickel onto Sintered Cu-W Alloys
National Association of Corrosion Engineers	Materials Selection & Corrosion Prediction Oil & Gas Ind.
National Association of Corrosion Engineers (3)	Development of Computer Software for Corrosion Control
National Center for Manufacturing Sciences	Development of Alternatives for Lead Based Solders

\* Number in parenthesis indicates number of same subject agreements





## SUCCESS STORIES

FY 1993

In a drive to continually improve the process by which the Materials Science and Engineering Laboratory conducts its research agenda development, resource allocation, and program evaluation mechanisms, the Laboratory has increased its efforts in tracking the impacts of its primary programs on its partners and U.S. industry. The following listing presents a sampling of the Laboratory's more significant successes in FY 1993.

CUSTOMER	TECHNOLOGY	IMPACT
Electronics Industries	Development of Lead-Free Solders	Working with the NCMS-organized consortium, MSEL calculated and evaluated phase diagrams which have been critical for down-selection from a list of 50 candidate systems.
Ceramics Producers	Measurement Standard for Flexure Strength	MSEL staff were instrumental in development of the new ASTM standard which results in a 50% reduction in specimen preparation costs. Lower cost and greater confidence in strength tests have prompted a surge in ceramic characterization for potential new applications.
Automotive Industry	Gas Metal Weld Process Control	MSEL weld control strategy has led to an inexpensive improvement in weld quality, reducing wear of electrical contacts, loss of gas coverage and detection of poor wire quality. Transfer of this technology to GM, Miller Electric and A. O. Smith is leading to improved weld quality and reduced cost in the workplace.

CUSTOMER	TECHNOLOGY	IMPACT
Automotive Industry	Process Control of Ferrite Magnets	Working with the Delco Chassis Division of General Motors, MSEL developed a measurement technique for control of strontium ferrite slurry processing. (strontium ferrite is used to produce 60 million magnets/year by GM). Delco reports increased magnet uniformity and recycle rate lowered from 40% to 20%.
Electronics Industries	Manufacture of Multilayer Capacitors	AVX (largest U.S.-based manufacturer) used MSEL-developed measurement and analyses to vary composition of a ceramic leading to improved materials and decreased product loss from thermal shock failure. AVX estimates a cost saving of \$1M from this 2 FTE effort by MSEL staff.
Automotive Industry	Rapid Forming of Large Structural Composites	Working with the Automotive Composites Consortium, MSEL provides permeability data, standard test methodology and process simulation required to explore the potential viability of resin-transfer molding as a fabrication technology. Process simulation is critical because full-scale experiments on large parts are very expensive.
Automotive Industry	Materials Selection for Tires	In a collaborative program with GenCorp and Goodyear, MSEL developed improved methods for predicting data for whole classes of polymers, eliminating the more costly Edisonian search for new materials. These methods are now used by Goodyear to help design new tires from materials combining wet skid resistance and long wear.

CUSTOMER	TECHNOLOGY	IMPACT
Broad Industry Community	Characterization of Surfaces, Interfaces and Thin Films	MSEL scientists have developed the world's best capability for neutron reflectivity. This methodology will enable structural characterization for the first time in materials including thin polymer films, magnetic multilayers and biomolecular assemblies.
Broad Industry Community	Organization of Corrosion Data Base for Added Value	The MSEL/Natl. Association of Corrosion Engineers program produces PC-based modules. After only three uses of one module, one company reported cost savings 2-3 times their investment in the entire series of 12 modules.
Aircraft Engine Manufacturers	Production of Metal Powder for High Strength "Super Alloys"	The MSEL/CSTL/MEL-led consortium developed an intelligent processing system combining process models, sensing and neural-network control, one CRADA partner certified a 40% scrap reduction.
Broad Industry Community	Ultrasonic Inspection of Composites	MSEL has developed model-based measurement methods for detecting elastic-property variations and related these to fiber orientation, distribution and volume fraction in composites. Joint instrument development with RITEC, an instrument company, lead to applications in aerospace (Lockheed), construction (XXSYS), automotive (GM) and materials development (GE).



# **NIST And MSEL Organization Charts**





# National Institute of Standards and Technology

## Organizational Chart

