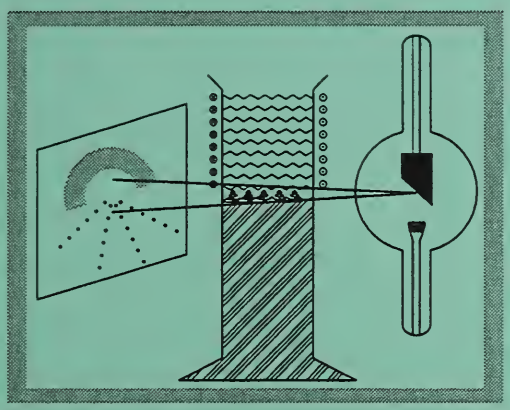
MSEL

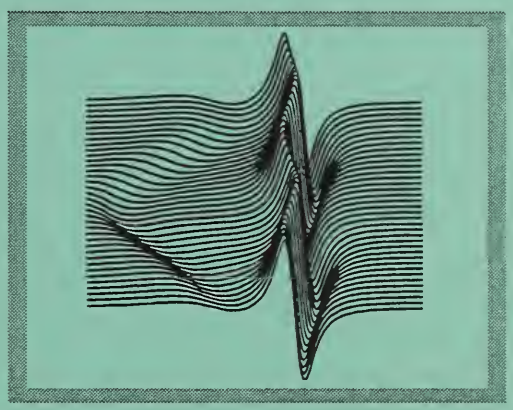
Materials Science and Engineering Laboratory

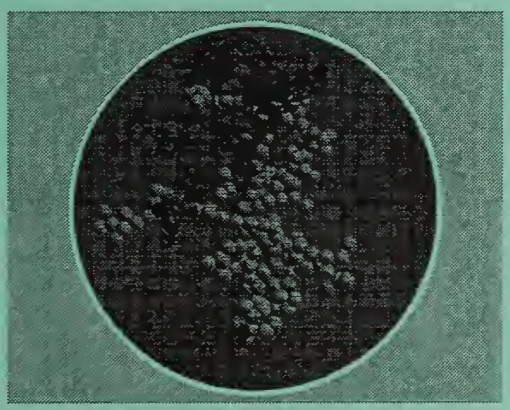
ANNUAL REPORT

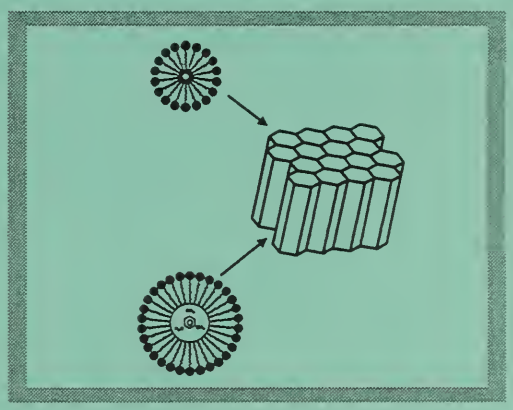
1994

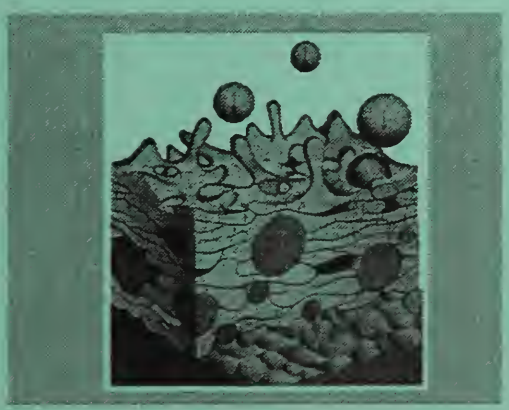
NAS-NRC
Assessment Panel
April 6-7, 1995

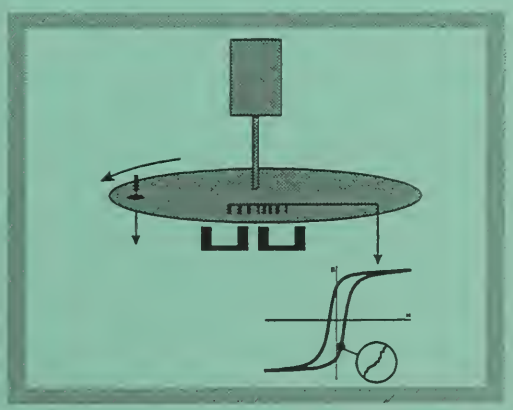












NISTIR 5577

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.

MSEL

Materials Science and Engineering Laboratory

ANNUAL REPORT

L.H. Schwartz, Director
H.L. Rook, Deputy

NAS-NRC
Assessment Panel
April 6-7, 1995

NISTIR 5577
U.S. Department of Commerce
Technology Administration
National Institute of Standards
and Technology

Technical Activities 1994

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

TABLE OF CONTENTS

	Page
AGENDA	iii
MEMORANDUM FROM THE DIRECTOR'S OFFICE	vii
OFFICE OF THE DIRECTOR	ix
PREFACE	xiii
INTRODUCTION	1
Background	3
Selected Accomplishments and Impacts	9
RESOURCES	13
Budget Profile	15
Summary of MSEL Staff.	17
NRC-NAS Postdoctoral Program	18
Academic Program	19
Visiting Scientist Program	20
NIST Fellows	21
Honors and Awards	23
External Recognition	27
TECHNOLOGY TRANSFER	39
Partners in Research	41
Standards Committees Membership	42
Research Dissemination	43
Patents	45
Standard Reference Materials	55
Conference Program	57
APPENDICES	71
A. 1993 Panel Members	73
B. Cooperative Research and Development Agreements	75
C. NIST Organizational Chart	83
D. MSEL Organizational Chart	84
E. Response to Prior Year Panel Recommendations	85

AGENDA

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

Wednesday, April 5, 1995

6:00 p.m.	Dinner - Panel Chairman, Lyle Schwartz, Harry Rook	

Thursday, April 6, 1995

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

Lecture Room A, Administration Building

8:00 a.m.	Coffee and Donuts	
8:10 a.m.	NRC Charge to the Panel	D. Zolandz
8:25 a.m.	Strategic Overview of MSEL	L. Schwartz
9:30 a.m.	Welcome & NIST Overview	R. Kammer
9:45 a.m.	Break	
10:00 a.m.	Overview of Polymers	L. Smith
10:20 a.m.	Discussion	
10:25 a.m.	Overview of Ceramics	S. Freiman
10:45 a.m.	Discussion	
10:50 a.m.	Overview of Metallurgy	N. Pugh
11:10 a.m.	Discussion	
11:15 a.m.	Overview of Materials Reliability	H. McHenry

11:35 a.m. Discussion

11:40 a.m. Overview of Reactor Radiation M. Rowe

12:00 p.m. Discussion

12:05 p.m. Lunch - Dining Room C
Panel members, L. Schwartz, H. Rook, Division Chiefs, D. Butrymowicz, J. Early, S. Schneider, and M. Kaufman

Lecture Room B

12:45 p.m. Poster Presentations on:

"Theory, Modeling, and Computational Sciences"

(1) "Modeling Solder Flow with Evolver"
Carol Handwerker

(2) "Modeling Microstructure Evolution -- Dendritic Growth During Solidification"
Jim Warren and Bill Boettinger

(3) "Crystal Growth"
John Cahn, Andy Roosen, and Craig Carter

(4) "Reactive Phase Separation in Polymers"
Sharon Glotzer and Ed DiMarzio

(5) "Elastic Green's Function Method for Modeling the Mechanical Behavior of Advanced Materials"
Vinod Tewary

(6) "Modeling and Computation for Ceramic Materials:
- Simulations of Sintering in Powder Compacts,
- Calculations of Rearrangement Forces in Particulate Systems,
- Simulation of Residual Stresses and Fracture Process"
Ed Fuller and Craig Carter

Lecture Room B (Continued)

(7) "Modeling of Permeability in Fibrous Materials for Liquid Composite Molding Applications"
Fred Phelan

(8) "Theory and Modeling for Neutron Condensed Matter Science"
Taner Yildirim

(9) "Theory Center Server"
Jim Warren and Andy Roosen

Lecture Room A

1:30 p.m.	Overview of Office of Intelligent Processing of Materials/Distributed Center for Theory and Modeling	D. Hall
1:50 p.m.	Discussion	
2:00 p.m.	Executive Session -- Chairman's Comments	
	Brief discussion by subpanel spokesperson for the following Divisions:	
2:30 p.m.	Materials Reliability	
2:45 p.m.	Metallurgy	
3:00 p.m.	Break	
3:15 p.m.	Ceramics	
3:30 p.m.	Polymers	
3:45 p.m.	Decision issues for discussion with Director/Division Chiefs	
4:15 p.m.	Panel discussion with Director and Division Chiefs	
5:30 p.m.	Adjourn	
	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, S. Schneider, and M. Kaufman

9:30 p.m. Panel members ride back to hotel with Division Chiefs

Friday, April 7, 1995

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

Dining Room C

8:15 a.m. Coffee and donuts

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

Dining Room C

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

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 7.

Panel members requiring special arrangements to airport on Friday, April 7, should contact Dan Butrymowicz/Linda Leaman on Thursday, April 6.

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

OCT 31 1994

MEMORANDUM FOR Materials Science and Engineering
Laboratory Panel

From: Arati Prabhakar
Director

Subject: National Research Council (NRC) Panel Meeting at NIST

I am pleased to welcome you to NIST. The efforts and insights you bring to the NRC Board on Assessment review process are very valuable for me and our Laboratory Directors. The Board will rely on your assessment to synthesize and integrate a NIST-level report for FY 1995.

NIST continues to play a major role in President Clinton's strategy for developing U. S. civilian technology. The appropriated budget for NIST's laboratories has grown by 37% since FY 1993 and is scheduled to increase from $264 million in 1995 to the President's planned level of approximately $400 million in 1997, *while maintaining approximately the same staff levels*. This necessitates a strong planning process and the need for setting priorities within each laboratory in order for the laboratory missions to be effectively accomplished.

Your job as an NRC panel member reviewing the quality of the technical effort in each laboratory is extremely important. The individual panels bring a wealth of scientific and technical experiences to the assessment process which will play a significant role in helping to evaluate the present state of NIST's laboratories as well as shaping their future. This year, your assessment of each laboratory should continue to focus on the following topics:

- Quality and effectiveness of each laboratory's current technical programs
- Each laboratory's priorities and priority-setting process
- Each laboratory's impact on industry and how this impact is measured
- Status of each laboratory's equipment and facilities as well as current and future needs

There are two additional areas of each laboratory's work that I would like you to assess this year:

- How well each laboratory is implementing the NIST Industry Fellows Program
- The work each laboratory does with data programs

Thank you again for taking the time to work with us.

cc: Executive Board

OFFICE OF THE DIRECTOR

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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 1994 Annual Report was prepared for the NAS-NRC Board of Assessment of the MSEL and is being made available to Assessment Panel Members for the April annual meeting. The report contains background information on the vision, mission, priority-setting process, implementation and organization of MSEL, as well as accomplishments and impacts, resources, activities, and technology transfer for the Laboratory. 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.

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 6, 1995

Introduction

BACKGROUND

Materials are the building blocks of modern society and are central to the reliable and efficient functioning of engineering structures and advanced 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 and material structures.

VISION

NIST's Materials Science and Engineering Laboratory seeks to be the ***central resource within the federal government in support of technology development in advanced materials and advanced processing of materials for application in the civilian economy. The Laboratory aims to exercise leadership through coordinated participation with other federal laboratories, industrial laboratories, and universities in national materials technology programs.***

MSEL has traditionally functioned as the leading federal laboratory for measurement-related civilian research and development, supporting the materials producing and using industries, universities, and other branches of the government. Measurement-related research leads to the development of standards, test methods, and reference materials and data that are crucial to industry's success in exploiting the potential technological advantages of advanced materials and advanced processing of materials.

While maintaining its vital and unique traditional role, MSEL has broadened its scope to encompass joint technology development in collaboration with industry, universities, and other government agencies. As the government research organization with historic ties to industry, MSEL is well positioned to play a lead-role in stimulating program coordination amongst Federal and industrial laboratories and universities in achieving national materials goals. The Laboratory's attention is focused on the materials producing and using industries and on important civilian technology applications of advanced materials and advanced processing of materials in transportation, communications, electronics, and construction.

MISSION

The mission of the MSEL is to ***stimulate the more effective production and use of materials by working with industry in the development and implementation of technology, measurements, and standards.*** MSEL contributes to the development of strategic and emerging technologies affecting U.S. competitiveness by providing generic and supporting technologies that assist U.S. industry in increasing productivity, quality, and rates of commercialization of new advanced materials as well as commodity materials.

The core program of MSEL addresses both the scientific and measurement issues that are central to industry's success in rapidly exploiting the potential technological advantages of advanced materials. The program also contributes to the development of process technologies which transform new advanced materials from laboratory curiosities to viable products and advanced manufacturing processes that reliably yield high quality products at reasonable cost.

Building on its long history of collaboration with U.S. industry, MSEL seeks to play a major role in assisting industry to define the R&D agenda and to develop the technology, data, and standards needed for the rapid and cost effective commercialization of many of these materials and associated materials processing technology. MSEL also aims to function as a hub for coordinating multi-agency programs to help optimize the Federal efforts in materials science and technology.

PRIORITY-SETTING PROCESS

The Materials Science and Engineering Laboratory plans its programs in response to NIST's enabling legislation, Executive and Congressional policies and with an understanding and close tie to national trends in industrial and manufacturing technologies. Accelerated development, commercialization, and adoption of new technology by U.S. industry are driving elements of the Administration's plan for sustained U.S. economic growth and the Administration has resolved to make the Department of Commerce (DoC) and NIST key players in these plans.

During the 1980s, a concurrent change in Presidential policy and Congressional focus on enhanced industrial competitiveness in the international arena has led NIST to expand its traditional role. New programs enacted by Congress intend to aid U.S. industries in developing technologies leading to new products or in improving current product quality, performance and cost - thus improving international competitiveness. Using different approaches, these programs utilize national efforts to accelerate the development of pre-competitive generic technologies, and regional efforts to enhance existing manufacturing by directly transferring government developed technologies to individual companies.

At the national level, materials technology remains a focus of Administration planning. In 1993 and 1994, MSEL played a leadership role within the White House Office of Science and Technology Policy (OSTP) and Office of Management and Budget (OMB) supported budget cross-cut on the Federal effort in materials science and technology. This crosscut led the former Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to develop a Presidential Initiative, the Advanced Materials and Processing Program (AMPP). In 1994, Dr. Lyle H. Schwartz, MSEL Director, was named chair of the Materials Technology (MatTec) Subcommittee within the President's National Science and Technology Council (NSTC), Civilian Industrial Technology Committee. Designed to supersede the FCCSET Working Group on Materials (COMAT), today's MatTec provides strategic guidance, interagency planning and coordination, and private sector linkage on

policies and programs undertaken within the Administration impacted by advanced materials technology.

At the Laboratory level, a major aspect of the Laboratory's planning process is to utilize close cooperation with industry to identify areas that meet specific MSEL developed criteria and obtain input on national trends in materials research, measurement methods, reference data, and standards necessary to support manufacturing technologies. With this information, the Laboratory identifies gaps in current materials science research, data, and standards and develops plans whereby the Laboratory can make the broadest impact on major industrial sectors of the U. S. economy.

The Laboratory's efforts in joint technology development involve both materials producing and using industries. An evolutionary shift is underway in industrial R&D leadership away from primary materials producers to a shared leadership with materials utilization industries. In response to this shift, MSEL employs a number of strategies and criteria to identify key technologies and industrial sectors where the Laboratory's programs can have a major impact. The criteria include:

- must have significant national impact in civilian technology area;
- able to build on existing NIST/MSEL strengths; and
- MSEL results can assist in improving industrial competitiveness.

The manner in which MSEL establishes its priorities and continually evaluates and improves its planning process was reexamined when the Laboratory issued in January 1994 the revised version of its original 1991 strategic plan. Based on an approach used by industrial R&D organizations for strategic planning, the 1994 plan gave a new strategic thinking for MSEL in research agenda development, resource allocation, and program evaluation mechanisms.

PROGRAM IMPLEMENTATION

MSEL uses a combined strategy of new program identification and development, emphasis on staff excellence, and flexibility in establishing partnership arrangements to ensure its continued position as a leader in materials science and technology. MSEL builds on its long-time relationships with many segments of the materials community by maintaining a continuing dialog with its varied customers and encouraging early participation by industry in developing collaborative projects. Concurrently, MSEL has assembled a quality staff with great breadth of expertise in all classes of engineering materials, including metals, ceramics, polymers, and composites.

Specialized facilities within MSEL have been developed, continually upgraded, and made available to outside researchers to provide in one organization a unique, world class combination of X-ray, electron, and neutron methods and techniques. These capabilities span the whole spectrum of materials research activities, including fundamental properties (e.g. surface force measurements), processing (e.g. metal powder atomizer), characterization (e.g.

optical, electron, x-ray, and neutron scattering methods), and performance behavior (e.g. mechanical test systems).

This combination of expertise, capabilities, and availability of specialized facilities has led to wide recognition of MSEL as a center of excellence in materials science and technology. This recognition is manifested by the significant growth in contacts and requests from non-NIST research organizations to develop substantive technical collaborations with MSEL programs, staff, and facilities.

To continuously monitor and evaluate the impact and value of its programs on the industry segments with which it is collaborating, MSEL supports and conducts topical workshops, discussions with industrial researchers and other NIST visiting researchers, information exchange with other NIST laboratories, staff visits to industrial sites, and staff leadership positions and participation in Federal interagency committees, technical, professional, and standards organizations.

ORGANIZATION

The Materials Science and Engineering Laboratory is one of the eight technical laboratory-based operating units of the National Institute of Standards and Technology (NIST). The FY 1994 MSEL budget was approximately $65.6 million, including capital equipment acquisitions. MSEL has a total staff of 387, of which 79 percent are in full time scientific or technical support positions. In addition, MSEL had 525 visiting scientists and engineers during Fiscal Year 1994 involved in collaborative research and over 1025 research participants and users of the NIST research reactor and Cold Neutron Research Facility. These non-NIST researchers provide significant leverage of MSEL staff and resources.

The Laboratory consists of five technical divisions, including the three material specific divisions of Ceramics, Metallurgy, and Polymers, the interdisciplinary Materials Reliability Division, and the Reactor Radiation Division; and one independent program office, Intelligent Processing of Materials (see Appendix D). Each of the six units has the generic mission of fostering the economical processing and safe and efficient use of materials and materials products by improving materials quality, manufacturability, and reliability. This mission is accomplished through developing and disseminating standards, measurement methods, predictive models, evaluated data and reference materials, and the scientific, quantitative understanding that is fundamental to the synthesis, processing, characterization, properties, and performance of materials.

Office of Intelligent Processing of Materials (OIPM)

OIPM has the responsibility of fostering concepts, and building and overseeing programs in the intelligent processing of materials (IPM). The Office also administers the MSEL Center for Theoretical and Computational Materials Science (CTCMS). IPM programs encompass

the application and development of on-line, real-time process sensors; models that connect the process variables with the desired microstructure and macroscopic material properties; and computer control systems that incorporate the process models and sensor data and provide process control via a feedback loop. The CTCMS is a distributed center with members at NIST and elsewhere. Its primary purpose is to develop and apply state-of-the-art materials theory and computational techniques and to help industry integrate them into technology development.

Ceramics Division

The Ceramics Division conducts programs pertinent to advanced ceramic materials through fundamental and applied research, the development of standard test methodologies, the preparation of standard reference materials, and the evaluation and dissemination of standard reference data. The Division addresses key scientific issues concerned with the relations between processing and structure at the atomic, molecular, and microscale levels and the ways in which those structures affect properties and performance.

Materials Reliability Division

The Materials Reliability Division fosters the increased use of advanced materials in commercial products by research aimed at improving confidence in their service performance. Measurement technology is developed for process control to improve quality, consistency and manufacturability of materials, nondestructive evaluation to assure quality of finished materials and products, fitness-for-purpose standards to relate material quality to reliability and safety, and materials evaluation to assure reliable performance.

Polymers Division

The Polymers Division provides standards, measurement methods, and fundamental concepts of polymer science to assist U.S. industries that produce or use polymers as essential parts of their business. This broad mission has been focussed to match the finite resources and technical capabilities of the Division. Industrial input into program planning and direction come from NIST/Industry Workshops on topics important to the competitiveness of U.S. industries.

Metallurgy Division

Materials processing is now firmly established as the central thrust of the Division's programs, with a clear focus on process control. The Division's processing programs are grouped into four main areas, namely liquid-solid metal processing, electroforming, thin-film

vapor deposition, and processing of steel sheet. This strategy has allowed the Division to respond effectively to NIST's expanded mandate, fostering closer and more focused interaction with U.S. industry, and to retain its traditional strengths in measurement science.

Reactor Radiation Division

The Reactor Radiation Division has three primary responsibilities: to operate the research reactor (NBSR) as a NIST and national resource in a cost-effective manner while assuring the public safety; to conduct a broad program of materials research using neutron methods, while developing and maintaining state-of-the-art instrumentation to ensure the best utilization of the NBSR neutron scattering facilities; and to develop and operate the Cold Neutron Research Facility (CNRF) as a national center, providing unique measurement capabilities to U.S. researchers.

SELECTED ACCOMPLISHMENTS AND IMPACTS

To improve the process by which the Materials Science and Engineering Laboratory conducts its research agenda development, resource allocation, and program evaluation methods, MSEL is increasing its efforts in tracking the technical accomplishments and the impacts on U.S. industry of its programs. The following listing presents a sampling of the Laboratory's successes in FY 1994.

- The Office of Intelligent Processing of Materials (OIPM) launched a new distributed **Center for Theoretical and Computational Materials Science** that includes researchers from NIST and other institutions nationwide. The center's purpose is to stimulate the development of theory and modeling in materials research and its application to industrial problems. The center has already developed an active research agenda involving teams of researchers in several materials areas.

- As part of the materials theory center, NIST developed and put on-line a **Mosaic-based server** to provide information to theory center researchers and others in the theory and modeling community, and to serve as a collaborative research tool linking together researchers across the country electronically. This server, designed from the start to enable interactive communication, is one of NIST's first demonstrations of a true electronic collaborative network.

- Working closely with AT&T, NIST researchers developed the methodology and data to make **lifetime predictions** of the mechanical reliability of InP elements in undersea fiber optic cables.

- All preliminary work was completed in the preparation and evaluation of prototype **ceramic hardness standard reference materials (SRM's)**. An international round-robin project verified the suitability of the prototype SRM's.

- As a result of a unique wicking method developed at NIST, the primary phase field of **$YBa_2Cu_3O_x$ superconducting material** has been determined and preliminary results are in hand for the BiSrCaCuO 2212 phase. Knowledge of primary phase fields is critical in selecting chemical compositions of these high T_c superconducting materials.

- Four new CRADAs were negotiated to transfer NIST's **arc weld sensing** technology for either real time quality control on production lines or for understanding the basic phenomena that determine weld quality.

- Images of **misfit dislocations** in an optoelectronic, epitaxial thin film were acquired using a custom-built, low take-off angle, backscattered electron detector in the Scanning Electron Microscope. The specimen was an as-deposited film with no subsequent preparation. The results agreed with conventional measurements taken in a Transmission Electron Microscope.

- Two new projects were initiated with industrial members of the NIST/Industry Consortium on **New Measurement Technology for Polymer Processing.** Evaluation of an in-line fluorescence confocal sensor for measuring temperature profiles in extruded resins is underway with DuPont Co and development of a sensor to monitor fluorescence and pressure simultaneously is being carried out with Dynisco.

- A new light scattering/optical microscope detection system has been built and adapted to a shear rheometer (cone and plate or plate and plate geometries) for ***in-situ*, real time studies** of shear mixing and de-mixing of polymer blends. The instrument permits simultaneous characterizations in both real space via optical microscopy and reciprocal space via light scattering.

- A **finite element simulation** for predicting the permeability for arbitrarily complex textile micro-structures was developed. Comparisons have been made with experimental results for flow in a undirected material, and the results agree to within 20-40%. This is a major advance since this degree of agreement can be useful for many applications and previous models have been in error by more than an order of magnitude.

- The National Association of Corrosion Engineers (NACE)-NIST co-sponsored **Corrosion Data Program** continued to collaborate with industry to produce personal computer based corrosion information and advisory systems. During FY94, three systems were released for public distribution and four more systems were distributed to industrial review committees for evaluation prior to public release. This brings the total number of systems developed by this joint activity and in public distribution to twelve.

- MSEL corrosion researchers working with the Fire Science Division of the NIST Building and Fire Research Laboratory, evaluated the potential for failure of **fire suppressant storage and handling systems**. System failures can occur due to corrosion of the metal parts when they are exposed to the non-ozone depleting alternatives to the CFC Halon 1301.

- MSEL researchers collaborating with the U.S. microelectronics industry in a National Center for Manufacturing Sciences (NCMS) led consortium project on **lead-free solders** provided measurements that helped consortium scientists select the most promising lead-free solder alloys from 65 possible candidates. Multicomponent phase diagrams and other data from NIST also are being used to identify additional candidate systems.

- A major shutdown of the **NIST Research Reactor and Cold Neutron Research Facility** began in May 1994 with an expected duration of about 9 months. During this period, a number of upgrades are being accomplished.

  . The two tube-and-plate heat exchangers are being replaced by three plate-type heat exchangers, any two of which are sufficient for 20 MW operation.
  . A new spherical shell geometry liquid hydrogen cold source is being installed. The design for this unique moderator was the result of extensive review by external experts.
  . The three final neutron guides are being installed bringing the total number of guides to eight. Supermirror coatings ($2\gamma_c$ of natural Ni) are being incorporated on the top and bottom surfaces of each guide.

- In collaboration with scientists from the Corrosion Research Center at the University of Minnesota and Johns Hopkins University, MSEL scientists have extended neutron reflectivity and small angle neutron scattering as probes for *in-situ* measurement of the structure of **metal oxide films under electrochemical control**. Reflectivity offers a spatial resolution unobtainable with any other *in-situ* probe, and small angle scattering is ideally suited to studying the evolution of electrode surface morphology. The techniques have been used recently to monitor a number of electrochemical processes, including oxide growth and homogeneity, dynamic roughening of electrode surfaces, re-passivation and healing phenomena, and heterogeneous dissolution of metals and semiconductor materials.

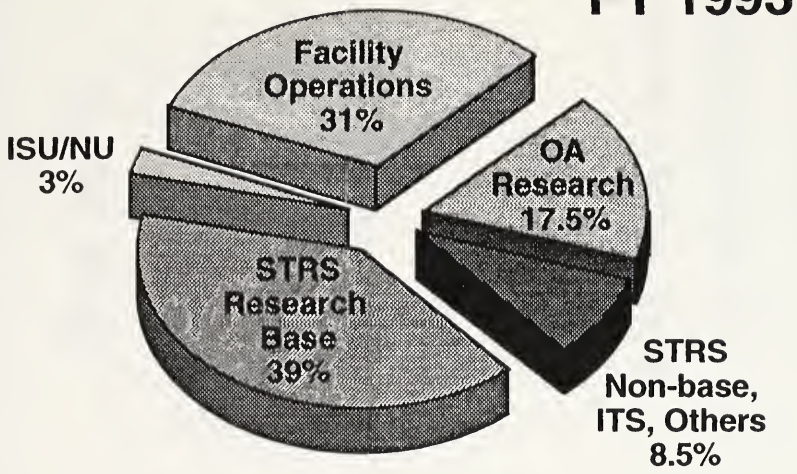
- Intense research on alternative refrigerants to chlorofluorocarbons (CFC's) is being driven by the looming ban on CFC productions in January, 1996. For compressors in home refrigerators and auto air-conditioning systems one replacement is hydrofluorocarbon (HFC) 134a ($F_3C\text{-}CFH_2$). A collaborative research effort between MSEL and E.I. DuPont is investigating, by neutron scattering and complementary techniques, the **bonding state and molecular dynamics of HFC 134a** and it's isomer HFC 134 ($HF_2C\text{-}CF_2H$), encaged in the cavities of zeolite molecular sieves. The insight gained from this collaborative research effort seeks to improve methods for the separation and storage of alternative refrigerants.

- A collaboration between MSEL and Los Alamos National Laboratory reports a major advance in establishing the **molecular mechanisms that regulate muscle contraction**. After Los Alamos scientists succeeded in preparing sufficient quantities of the protein complex troponin c/troponin I in the presence of calcium ($4Ca^{2+}$·TnC/TnI) with the TnC component fully deuterated, NIST and Los Alamos scientists completed SANS measurements at the CNRF. The SANS measurements, combined with existing x-ray data, have resulted in the first complete model for the complex, which has provided new insights into its critical role as a molecular switch during muscle contraction.

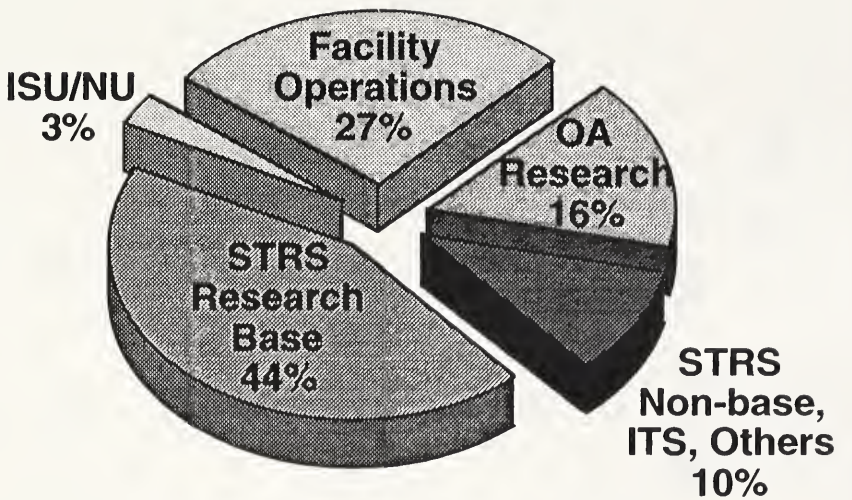
Resources

MSEL BUDGET PROFILE

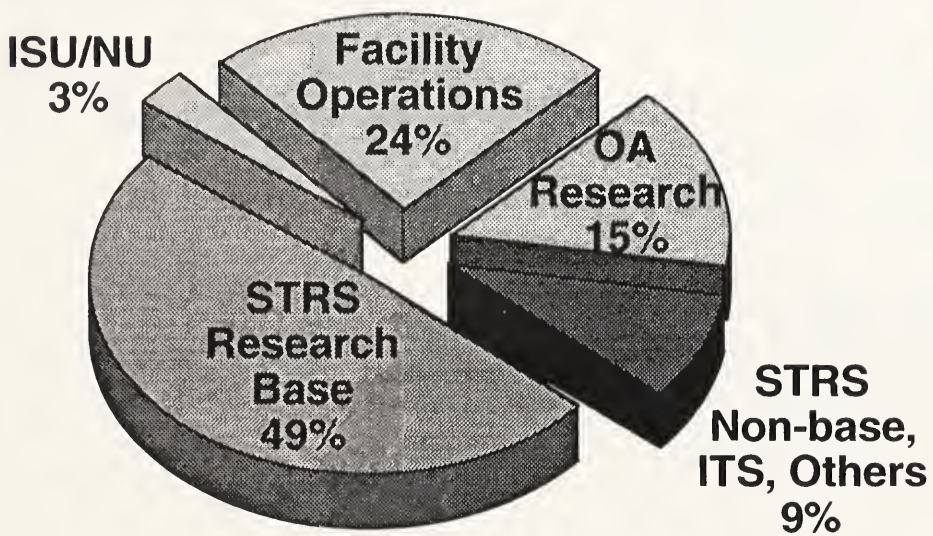
FY 1993 - FY 1995



FY93 Total $57.1M



FY94 Total $62.5M



FY95 Total $66.6M*

* Estimate

SUMMARY OF MSEL STAFF

1992-1994

Full Time Permanent	FY 1992	FY 1993	FY 1994
Physicist	61	62	59
Chemist	48	45	38
Metallurgist/Matls. Scientist	44	48	20
Engineer	44	38	53
Physical Scientists*	---	---	33
Other	17	15	4
Subtotal	**214**	**208**	**207**
Technical Support	39	40	30
Reactor Operators	15	16	26
Management Support	8	8	7
Secretarial/Admin. Support	39	35	35
Subtotal	**101**	**99**	**98**
TOTAL FTP	**315**	**307**	**305**
Other			
NRC-NAS Postdoctorals	10	13	10
Part-Time and Temporary	46	54	54
Academic (Student and Faculty)	19	22	18
Subtotal	**75**	**89**	**82**
TOTAL STAFF	**390**	**396**	**387**

* Multidisciplinary personnel, professional, accounting category.

NRC-NAS POSTDOCTORAL PROGRAM

MSEL - FY 1994

Unit	Name	Degree	School	Position Title	Advisor
Materials Reliability	Keller, Robert	Matls. Sci./Engr.	U. of MN	Matls. Res. Engr.	Read
Polymers	Factor, Bradford	Physics	Stanford U.	Physicist	Han
	Glotzer, Sharon	Physics	Boston U.	Physicist	DiMarzio
	Gusler, Gloria	Poly.Sci./Engr.	U. of CA	Chem. Engr.	McKenna
	Macturk, Kenneth	Poly.Sci./Engr.	U. of Akron	Phy. Sci	Schutte
	Wallace, William	Poly.Sci./Engr.	U. of PA	Phy. Sci	Davis
	Van Zanten, John	Chem. Engr.	UCLA	Chem. Engr.	Wu
Metallurgy	Roosen, Andrew	Mathematics	Rutgers U.	Mathematician	Cahn
Reactor	Dura, Joseph	Physics	U. of IL	Physicist	Majkrzak
	Reznik, Demitry	Physics	U. of IL	Physicist	Neumann

ACADEMIC PROGRAM

MSEL
FY 1994 Appointments

	Students	NRC/NAS Postdoctorals	Faculty	Totals
Laboratory Office	1	----	----	1
Ceramics	1	----	1	2
Materials Reliability	----	1	1	2
Polymers	11	6	-----	17
Metallurgy	1	1	1	3
Reactor Radiation	----	2	1	3
Totals	14	10	4	28

VISITING SCIENTIST PROGRAM

MSEL

1992-1994

Guest Researchers	FY 1992	FY 1993	FY 1994
Domestic			
Government	46	42	32
Academic	116	128	121
Industry	70	68	57
Self-Employed	26	25	26
Subtotal	258	263	236
Foreign	202	244	228
Subtotal	**460**	**507**	**464**
Research Associates			
Government	4	3	3
Academic	-----	1	1
Industry	45	6	7
Research Agreements			
Government	-----	-----	-----
Academic	-----	-----	2
Industry	11	41	45
Foreign	-----	-----	1
Subtotal	**60**	**51**	**59**
Intergovernmental Personnel Act (Academic)	1	1	2
TOTAL	**521**	**559**	**525**

NIST FELLOWS

1994

The NIST Fellows program was established by the NIST Director to provide recognition to NIST's most outstanding scientists. Senior Fellows and Fellows within the Materials Science and Engineering Laboratory include the following distinguished personnel.

Senior Fellows	John Cahn
	Sheldon M. Wiederhorn
Fellows	Brian Lawn
	John J. Rush
	Robb M. Thomson

HONORS AND AWARDS

1992-1994

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)

SILVER MEDAL (Meritorious Service)

William J. Boettinger	for research on metal solidification and casting that made predictive modeling possible in new industrial process technology areas. (1994)
Carol A. Handwerker	for innovative research on solder properties important for micro-electronics. (1994)
John R. Copley **Dan A. Neumann**	for leadership in seminal and timely neutron studies of critical molecular-scale properties. (1994)
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)

BRONZE MEDAL (Superior Service)

Daniel A. Fischer	for determining the structure and orientation of molecules at metal/polymer interfaces in multilayer interconnect devices. (1994)
Frederick R. Phelan, Jr.	for developing finite-element models and animation software. (1994)
John H. Ring	improving the efficiency of operation, thusly reducing the need for maintenance of the thermal shield, a critical component in the NIST Research Reactor. (1994)
Sushil K. Satija	for development of a new cold neutron reflectometer in the NIST Cold Neutron Research Facility. (1994)
John H. Smith	for being a research team member that developed and implemented instrumentation, metrology frame, artifacts, and procedures for microform calibration. (1994)
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)

SPECIAL ACTS

James Kelly **James Kline** **Lin-Sien Lum** **Subhas Malghan** **Dennis Minor** **Patrick Pei**	Standard Reference Materials Program Special Service Award. (1993)
Carol A. 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)

Francis Biancaniello **Paul Boyer** **Robert Parke** **Stephen Ridder** **H. Thomas Yolken**	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)

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

J. Michael Rowe **John Rush**	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)

EXTERNAL RECOGNITION

1992-1994

George A. Alers	Elected to the Administrative Committee of the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society (1994)
	Appointed Technical Program Chairman for the 1995 IEEE Ultrasonics Symposium (1994)
	Appointed to the graduate Faculty of Iowa State University, Department of Aerospace Engineering and Engineering Mechanics (1994)
D.B. Anderson	ASTM Committee E-49, Award of Appreciation (1992)
Joseph M. Antonucci	Consultant to NIDR, Small Business Grants Study Section (1984-1991); Chairman (1992)
	Member of Committee for Wilmer Souder Award (1992)
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)
William Boettinger	Elected Fellow of ASM International (1994)
Julie L. Borchers	NATO grant for collaborative research effort at Riso National Laboratory in Denmark (1994)
	Program Committee, Joint Magnetism and Magnetic Materials (MMM) and Intermag conference (1994)

John W. Cahn	Presented Gold Medal, Japan Institute of Metals (1994)
	Granted Honorary Membership, Japan Institute of Metals (1994)
	Presented Rockwell Medal, International Technology Institute (1994)
	Inducted into Hall of Fame for Engineering, Science and Technology, International Technology Institute (1994)
	Affiliate Professor, University of Seattle - Materials Engineering and Physics (1994)
	Cyril Stanley Smith Lecture - University of Chicago (1993)
	Inland Steel Lecture - Northwestern University (1993)
	William Hume-Rothery Award, TMS (1993)
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 R. Coriell	Associate Editor, Journal of Crystal Growth (1994)
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)

Ed Escalante	ASTM SAM Tour Award - Technical Paper of Outstanding Merit in the field of improvement and evaluation of corrosion testing methods. Measuring the Underground Corrosion of Steel Piling at Turcot Yard, Montreal, Canada - a 14 Year Study (1994)
	Co-Chairman, ASTM Symposium, Techniques to Assess the Corrosion Activity of Steel Reinforced Concrete Structures (1994)
Christopher M. Fortunko	Appointed Fellow by courtesy in the Department of Materials Science and Engineering at the Johns Hopkins University (1994, 1993, 1992)
	Co-Chairman, Gordon Conference on NDE (1994)
	Appointed to the Graduate Faculty of Iowa State University, Department of Aerospace Engineering and Engineering Mechanics (1994)
Anna C. Fraker	Elected ASM International Fellow (1993)
Stephen Freiman	Received the Distinguished Alumni Award from the Department of Materials Science and Engineering at the University of Florida (1994)
Charles J. Glinka	Member of the Materials Sciences Proposal Review Subcommittee of the Brookhaven HFBR Program Advisory Committee (1994)
	Member of the Brookhaven National Laboratory Neutron Advisory Group (1994)
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 Vice Chairwoman of Basic Sciences Division of American Ceramic Society (1994)
	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)
William A. Kamitakahara	Secretary, Neutron Scattering Society (1993, 1994)
David S. Lashmore	American Electroplaters and Surface Finishers Research Award (1993)
	Blum Award: Electrochemical Society, Washington, DC Chapter (1993)
Brian Lawn	Secured $5.4M research grant from National Institute of Dental Research, on dental ceramics, as part of a joint University of Maryland, University of Medicine and Dentistry at New Jersey, and NIST program (1994)
	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)

Jeffrey W. Lynn	Member, Advisory Committee for the Conference on Magnetism and Magnetic Materials (1993, 1994)
	Symposium Chairman, APS March Meeting (Pittsburgh, 1994)
	Symposium Chairman, Conference on Magnetism and Magnetic Materials (Albuquerque, 1994)
	Series Editor, Graduate Texts in Contemporary Physics (1994)
	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	International Advisory Committee for Workshop on Surface X-ray and Neutron Scattering (Dubna, Russia, 1993)
	Brookhaven High Flux Beam Reactor Program Advisory Committee (1990-1993)
	Working Group on Neutron Instrumentation, BESAC Panel on Neutron Sources (1992)
	1993 DOE Review Panel, ORNL ANS project (1992)
	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)
	Editorial Review Board, Journal of Rheology (1992)
Robert D. McMichael	Chairman of session for Intermag '94 (1994)
	Received Sigma Xi Young Scientist Award for Excellence in Scientific Research for work on the magnetocaloric effect (1994)
Leonard Mordfin	Charles W. Briggs Award of ASTM (1992)
Jasper L. Mullen	Resource Education Awareness Partnership (REAP) (1992)
Dan A. Neumann **C.M. Lieber**	Co-Chairman of Fullerenes sessions (DMP), APS meeting in Pittsburgh (1994)
Edward Prince	Publication Committee of the American Crystal Association (1994)
	Member, Commission on Neutron Scattering, International Union of Crystallography (1994)
	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	Presidential Rank Award of Meritorious Executive (1994)
	ANSI/ANS Standards Committees:
	Chairman ANS-15.1 - "Technical Specifications for Research Reactors (1992)

Tawfik M. Raby (Cont.)	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)
David T. Read	Received the Heterni Award from the Society for Experimental Mechanics for the Outstanding Technical Paper in Journal of Experimental Mechanics (1993)
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)
Harry Rook	Chairman, ISO/TC 146 Subcommittee 03 on Ambient Atmospheres (1992-1994)
	Chairman, ASTM Committee D-22 on Sampling and Analysis of Atmospheres (1992-1994)
	Chairman of Versailles Project on Advanced Materials and Standards (VAMAS) (1992)
J. Michael Rowe	Member, ad-hoc Committee on Materials Research Facilities, Natural Science and Engineering Research Council (NSERC) of Canada (1994)
	Review Committee for MIT Research Reactor (1994)
	Member, Search Committee for Director of Office of Basic Energy Sciences, DOE (1994)
	Fellow, American Physical Society (1993)

J. Michael Rowe (Cont.)	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) (1992)
John J. Rush	Member, National Science and Technology Council, Subcommittee on Research Infrastructure (1994)
	Member, Los Alamos Neutron Scattering Center Review Committee (1994)
	Co-Organizer, Workshop on Neutron Sources and Applications, Basic Energy Sciences Advisory Committee, DOE (1992)
	Member, Brookhaven National Laboratory Neutron Scattering Facility Scheduling Committee (1992)
	Member, International Conferences on Hydrogen in Metals Advisory Committee (1992-1994)
	Member, NAS/NRC Solid State Sciences Committee (1992-1994)
	Executive Committee, National Steering Committee for the Advanced Neutron Sources (1992-1994)
	Vice Chairman, Panel on Neutron Sources, Basic Energy Sciences Advisory Committee, DOE (1992)
	Co-Vice Chairman, DOE Basic Energy Sciences Advisory Committee, Panel on Neutron Sources (1992)

Robert J. Schaefer	Elected Fellow of ASM International (1994)
Michael A. Schen	Invited Co-Chair, American Society for Mechanical Engineers (ASME) Winter Annual Meeting, Symposia on Materials and Mechanics of Electronic Packaging (1994)
	Invited Member and NIST Representative, Institute for Interconnection and Packaging Electronic Circuits (IPC) Technology Roadmap Committee (1994)
	NIST Representative, National Science and Technology Council (NSTC), Materials Technology Committee, Electronic Materials Working Group (1994)
	NIST Representative, Semiconductor Research Corporation (SRC) Packaging Sciences Technical Advisory Board (1993-1994)
Samuel J. Schneider	Elected to International Academy of Ceramics (1994)
	Received International Ceramic Prize, awarded by Japan Fine Ceramics Association (1994)
	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	Presented 1993 National Materials Advancement Award, from the Federation for Materials Societies, Washington, DC (1994)
	Presented 1994 TMS Leadership Award, San Francisco, CA (1994)
	Inducted into the National Academy of Engineering (1994)

Robert D. Shull	Elected Chairman, TMS Chemistry and Physics of Materials Committee (1994)
	Re-elected Secretary/Treasurer of the International Committee on Nanostructured Materials (1994)
	Appointed to the Committee of Visitors to view the NSF Program on Fluid, Particulate, and Hydraulic Systems (1994)
	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	Selected as R.D. Thomas International Lecture Award for 1995 by American Welding Society (1994)
	FLC Award for Excellence in Technology Transfer (1994)
	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 **R. Bruce Madigan** **Timothy P. Quinn**	Poster Presentation, First Place Award, American Welding Society. Poster entitled, "Prevention of Contact Tube Melting in Arc Welding" (1994)
	Received the Federal Laboratory Consortium Award for Excellence in Technology Transfer (1994)
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)
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)
Vinod K. Tewary	Received the "Multicultural Award for Excellence in Science;" awarded by Boulder County (Colorado State) Department of Community Action Programs (1994)
	Received the Pride of India Award from the Bochasanwasi Swaminarayan Sanstha for contributions in the field of computational materials science (1992)
Ralph Tobler	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)
David L. Vanderhart	Elected Fellow, American Physical Society (1993)

Sheldon Wiederhorn	Editor, Journal of the American Ceramic Society (1994)
	National Research Council, Commission on Physical Sciences, Mathematics and Applications, Solid State Sciences Committee (1993-1994)
	National Research Council, Commission on Physical Sciences, Mathematics and Applications, AFOSR Materials Science Review Panel (1994)
	Awarded John Jeppson Award, American Ceramic Society (1994)
H. Thomas Yolken	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)

Technology Transfer

PARTNERS IN RESEARCH

MSEL CRADA AGREEMENTS - FY 1994

Active Agreements	FY 1992	FY 1993	FY 1994
NIST	192	309	414
MSEL	48 (25%)*	100 (32%)*	127 (31%)*
Industry	47	86	110
University	1	13	16
Government	--	1	1
New Agreements	24	58	32
Total Agreements (since 1988)	59	117	149

MSEL PARTNERS
Since 1988

	FY 1992	FY 1993	FY 1994
Partners			
Single Agreement	—	64	68
Multiple Agreements	—	19	22
TOTAL	—	**83**	**90**

Multiple Agreement Partners**

Aluminum Association, Inc. (2)
American Society for Testing and Materials (2)
Aristech Chemical Corp. (2)
Armstrong World Industries, Inc (2)
BDM, Inc. (2)
Crucible Metals Corp. (2)
Dentsply International, Inc. (2)
Dow Chemical Co. (3)
E.I. du Pont de Nemours & Co. (4)
Eaton Corp. (2)
General Electric Co. (5)
General Motors Corp. (8)
Grumman Aerospace Corp. (2)
Minnesota Mining & Manufacturing Co. (3M) (3)
National Association of Corrosion Engineers (4)
National Center for Manufacturing Sciences (2)
Norton Co. (4)
Raychem Corp. (2)
Rohm and Haas Co. (3)

* MSEL percentage of all active NIST agreements
** Number in parenthesis indicates number of agreements since 1988

STANDARDS COMMITTEES MEMBERSHIP

FY 1994

MSEL Unit	Staff	Memberships
Laboratory Office	4	14
Office of Intelligent Processing of Materials	-----	-----
Ceramics	17	71
Materials Reliability	7	15
Polymers	9	24
Metallurgy	22	82
Reactor Radiation	2	7
Office of Fiber and Film Technology	3	3
	64*	216

*Includes 34 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)
Electronic Industries Association (EIA)
European Thermophysical Properties Committee (ETPC)
Initial Graphics Exchange Specification/Product Data Exchange Specification (IGES/PDES)
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 1994

UNIT	PAPERS PUBLISHED	TALKS INVITED	PATENTS*	SRMS*	MONOGRAPHS
LABORATORY OFFICE	14	37	-----	-----	-----
OFFICE OF INTELLIGENT PROCESSING OF MATERIALS	-----	2	-----	-----	-----
CERAMICS	170	125	5	2	-----
MATERIALS RELIABILITY	73	20	4	3	-----
POLYMERS	167	96	4	-----	-----
METALLURGY	106	85	8	8	-----
REACTOR RADIATION	189	67	----	----	___
	719	432	21	13	___

PATENTS

FY 1992-1994

GRANTED AND PENDING

1994 - 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

Methods of Reducing Wear on Silicon Carbide Ceramic Surfaces
D. Deckman, S. Hsu (Ceramics)
Patent No. 5,344,577

Ultra-Fine Magnetic Particles Homogeneously Dispersed In A Dielectric Matrix
J. Ritter, R. Shull (Ceramics)
Patent No. 5,316,699

Sensing of Gas Metal Arc Welding Process Characteristics for Welding Process Control
R. Madigan, T. Quinn, T. Siewert (Materials Reliability)
Patent No. 5,349,156

Hydroxyfluoroalkyl-Substituted Styrenes and Polymeric Compositions Containing Same
C. Han (Polymers), two others (non-NIST)
Patent No. 5,272,232

Electroforming of Metallic Glasses for Dental Application
M. Ratzker, D. Lashmore (Metallurgy), J. Tesk (Polymers)
Patent No. 5,316,650

Method and Apparatus for Visualization of Internal Stresses in Solid Non-Transparent Materials by Elastoacoustic Technique
E. Drescher-K (Metallurgy)
Patent No. 5,307,680

Method for the Production of Predetermined Concentration Graded Alloys
D. Lashmore (Metallurgy), one other (non-NIST)
Patent No. 5,320,719

Predetermined Concentration Graded Alloys and Method for Production Thereof
D. Lashmore, M. Dariel (Metallurgy)
Patent No. 5,268,235

Process for Forming Alloys In-Situ In Absence of Liquid-Phase Sintering
D. Lashmore, M. Dariel, E. Escalante (Metallurgy), J. Tesk (Polymers)
Patent No. 5,318,746

1994 Pending

A Method for Obtaining High Density Green Ceramics
S. Malghan, R. Premachandran (Ceramics)
Application No. NIST 93-026 (1/13/93)
PTO 08/176,668 (1/3/94)

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

Gas-Coupled, Ultrasonic Wall-Thickness Measurement and Flaw Detection and Sizing in Pipelines
C. Fortunko, R. Schramm, W. Dube, J. McCloskey, M. Renken (Materials), two others (non-NIST)
Application No. NIST 94-036 (6/28/94)

Prevention of Contact Tube Melting to Arc Welding
T. Siewert, B. Madigan, T. Quinn (Materials)
Application No. NIST 93-057 (7/26/93)

Welding Electrode Composition for Cryogenic Service
T. Siewert, C. McCowan (Materials)
Application No. NIST 93-014 (11/12/92)
PTO 08/086,531 (7/1/93)

A Simple, Effective Method for Bonding to Mineralized Dental Tissue Using N-phenlininodiacetic Acid
J. Antonucci (Polymers), one other (non-NIST)
Application No. NIST 94-016 (12/9/93)
PTO 08/189,709 (2/1/94)

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

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

Functional Trivalent Chromium
C. Johnson, E. Soltani, D. Lashmore (Metallurgy)
Application No. NIST 92-051 (8/5/92)
PTO 08/107,833 (8/18/93)

Method and Apparatus for Visualization of Internal Stresses in Solid Non-Transparent Materials by Ultrasonic Techniques and Ultrasonic Computer Tomography of Stress
K. Drescher (Metallurgy)
Application No. NIST 94-017CIP (1/10/94)
PTO 08/237,099 (5/3/94)

Nanocomposite Material for Magnetic Refrigeration and Superparamagnetic Systems Using the Same
L. Bennett, R. Shull, L. Swartzendruber (Metallurgy)
Application No. NIST 93-028C (5/31/89)
PTO 08/107,883 (1/28/93)

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. Biancaniello (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)

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)

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)

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 (Polymers), one other (non-NIST)
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)

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)

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, Molybendum 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, Molybendum 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)

1992 - Granted

A Method for Fabrication of Materials from Nano-Sized Particles Using High Pressure and Cryogenic Temperatures (c)
G. Piermarini, A. Pechenik (Ceramics)
Patent No. 5,147,446

Calibration Block and Method for an Ultrasonic System
J.T. Miller and B.W. Staff (Lockheed Corp); C.M. Fortunko (Materials Reliability)
Patent No. 5,163,027 - Assigned to Lockheed Corp.

Ultrasensitive Force Detector Employing Servo-Stabilized Tunnelling Junction
J.M. Moreland (Electromagnetic Technology Division); W.P. Dube (Materials Reliability)
Patent No. 5,103,682

Ultrasonic Image Sensing Array and Method
P.L. Carson, A.L. Robinson, F.L. Terry, Jr. (University of Michigan); D.W. Fitting (Materials Reliability)
Patent No. 5,160,870 - Assigned to Inventors

Dental Resins Comprising Cyclopolymerizable Monomers
J.W. Stansbury (Polymers)
Patent No. 5145374, issued September 8, 1992

Optical Sensor for the Measurement of Molecular Orientation and Viscosity of Polymeric Materials Based on Fluorescence Radiation
A.J. Bur, C.L. Thomas, R.E. Lowry, F.W. Wang, S.C. Roth (Polymers)
Patent No. 5,151,748, issued September 29, 1992

Nitrogenated Stainless Steel Via Gas Atomization
F.S. Biancaniello, G.M. Janowski, S.D. Ridder (Metallurgy)
Patent No. 5,114,470, May 19, 1992

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
J. Ritter (Ceramics)
Patent No. 5,077,265

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 Ag3Sn 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)

STANDARD REFERENCE MATERIALS

FY 1994

Ceramics

SRM 1416: Liquidus Temperature (Alumino Silicate Glass)

SRM 656: X-Ray Phase Content (Silicon Nitride)

Materials Reliability

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

Metallurgy

SRM 1357, 1358, 1359, 1362, 1364a: Chrome on Copper on Steel (Coating Thickness)

SRM 1894 25, 50: 100g Vickers Copper Microhardness Standard

SRM 1906: 500g Knoop Nickel Microhardness Standard

CONFERENCE PROGRAM

(SPONSOR OR CO-SPONSOR)

FY 1992-1994

1994

NIST Workshop on Nanotechnology September 19, 1994 (R.D. Shull-Metallurgy) 75 attendees	A planning workshop for NIST Laboratory Directors.
Total Joint Replacements Workshop September 1-2, 1994 (J. Tesk-Polymers) 40-60 attendees	To assess role of NIST in helping orthopedic manufacturers solve problems with performance of total joint implants in a $4.5B world-wide business.
American Chemical Society Symposium: Scattering from Polymers: Small Angle and Reflectivity August 21-26, 1994 (B. Hammouda-Reactor Radiation and ACS) 90 attendees	To acquaint polymer scientists with neutron techniques for the characterization of polymers.
Workshop on Green's Function and Boundary Element Analysis for Modeling of Mechanical Behavior of Advanced Materials August 14-17, 1994 (V.K. Tewary-Materials Reliability) 30 attendees	A workshop sponsored by the NIST Center for Theoretical and Computational materials Science to discuss uses of Green's functions and identify areas for collaboration involving NIST, industry and universities.
ATP Workshop on Materials Processing August 16, 1994 (T.A. Siewert-Materials Reliability) 400 attendees	A NIST Advanced Technology Program (ATP) workshop to identify research opportunities which might be addressed in an ATP program on materials processing.

Computerized Welding Information - V Conference August 9-12, 1994 (NIST, Colorado School of Mines, American Welding Institute, and the American Welding Society) 60 attendees	The fifth in a series of conferences to review development in sensing, welding and control of welding processes.
Workshop on Interface Motion in Multicomponent Media July 24-August 13, 1994 (J. Cahn-MSEL, J. Simmons-Metallurgy, and ARPA) 40 attendees	A three-week workshop that brought together materials scientists and mathematicians from all over the world to discuss modern methods of mathematically modeling interface motion effects important in materials processing and manufacturing.
Twelfth Symposium on Thermophysical Properties June 19-24, 1994 (A. Cezaurliyan-Metallurgy and ASME) 400 attendees	A symposium involving physicists, chemists and materials scientists from over 30 countries to attend more than 50 technical sessions where more than 300 papers were presented.
Workshop on Solder Joint Engineering May 31-June 2, 1994 (C. Handwerker-Metallurgy, NIST Center for Theoretical and Computational Materials Science, NSF) 17 attendees	A workshop to examine how interface shapes for complex solder joint geometrics can be determined and how the resulting shapes can be incorporated into finite element analyses for joint strength an into heat flow programs for assessment of thermal management.
Joint NSF-NIST Conference on Ultrafine Particle Engineering May 25, 1994 (R.D. Shull-Metallurgy) 50 attendees	A joint industrial/university conference for forming partnerships in the use, preparation and understanding of nanometer-sized particulates.

Workshop on Materials Metrology and Data for Commercial Electrical and Optical Packaging and Interconnection Technologies May 5-6, 1994 (M.A. Schen-Polymers, Inst. for Interconnecting & Packaging Electronic Circuits, Optoelectronics Industry Development Association, and Semiconductor Research Corp.) 104 attendees	A workshop to develop a national consensus in materials research and metrology supporting commercial electrical and optical packaging and interconnection technologies for the U.S. microelectronics industry.
American Physical Society Short Course: High Polymer Physics March 19-20, 1994 (B. Hammouda-Reactor Radiation, and American Physical Society) 75 attendees	To instruct polymer scientists in the techniques of small-angle neutron and x-ray scattering from polymer.
American Physical Society Short Course: Neutron and X-Ray Scattering Methods in Polymer Science March 1994 (B. Hammouda-Reactor Radiation, J. Barnes-Polymers, American Physical Society 70 attendees	Comprehensive overview of neutron and x-ray scattering methods as applied to polymer characterization with emphasis on modern methods using advanced detectors and radiation sources available at NIST.
Processing of Nanocrystalline Materials Symposium February 27-29, 1994 (R.D. Shull-Metallurgy, Minerals, Metals and Materials Society) 150 attendees	Symposium at the Annual TMS Meeting for industry, government and university researchers.
Materials Technology on the Nano-Scale in Year 2000 Symposium February 27, 1994 (R.D. Shull-Metallurgy, Minerals, Metals and Material Society) 150 attendees)	Symposium at the Annual TMS Meeting for industry, government and university researchers.

Workshop on Characterizing Diamond Films III February 23-24, 1994 (A. Feldman-Ceramics) 35 attendees	A workshop to provide an update on characterization technique development.
NIST Cold Neutron Research Facility Researchers' Group Meeting December 10, 1993 (W. Kamitakahara and C. Glinka-Reactor Radiation) 50 attendees	To review recent work at the CNRF, discuss procedures and future plans.
Workshop on the State-of-the-Art in Neutron Reflectometry December 9-10, 1993 (C. Majkrzak and S. Satija-Reactor Radiation) 100 attendees	To discuss recent developments in an applications of neutron reflectometry in many diverse fields.
Workshop on Composite Materials for Offshore Operations October 26-28, 1993 (D.W. Fitting-Materials Reliability, Minerals Management Service, University of Houston) 215 attendees	A workshop to identify and prioritize R&D needs for the safe and economical use of composite materials in offshore structures and equipment.
ASTM Fourth International Symposium on the Computerization and Use of Materials Property Data October 6-8, 1993 (C.P. Sturrock-Metallurgy, E.F. Begley-Ceramics, and ASTM Committee E49) 50 attendees	Jointly sponsored by NIST and ASTM Committee E49 on Computerization of Material and Chemical Property Data. To increase the value, as seen by end users, of materials data incorporated within computerized materials information systems leading to greater reliability, acceptability, and usage of these systems.

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 Compiégne, 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 Optoelectrical 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.

Appendices

APPENDIX A

1994 PANEL MEMBERS

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APPENDIX B

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

FY 1988 - FY 1994

PARTNER*	SUBJECT
Materials Science and Engineering Laboratory	
Single Agreements	
General Electric Company	Ceramics for Gas Turbines
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, Inc. American Foundrymen's Society Auburn University Case Western Reserve University GE Aircraft Engines General Motors Corporation, Allison Gas Turbine Division Howmet Corporation Lockheed Idaho Technologies Co. Massachusetts Institute of Technology PCC Airfoils, Inc. Pennsylvania State University, Purdue University UES, Inc.	Consortium on Modeling of Casting of Aerospace Metal Alloys

PARTNER*	SUBJECT
United States Department of the Interior University of Alabama University of Arizona University of Illinois Worcester Polytechnic Institute	
Cercom Inc. Coors Ceramics Company Eaton Corporation Kerr-McGee Corporation Matec Applied Sciences, Inc. Norton Industrial Ceramics Company	Intelligent Processing of Ceramic Powders Consortium
Aristech Chemical Corporation Armstrong World Industries, Inc. Goodyear Tire and Rubber Company Minnesota Mining and Manufacturing Co. (2) Raychem Corporation (2) Rohm and Haas Company	Polymer Blends Consortium
Dow Chemical Company du Pont Flow Vision, Inc. Minnesota Mining and Manufacturing Co. Rohm and Haas Company	Polymer Processing Consortium
Crucible Compaction Metals Metallurgy, Inc. United Technologies, Pratt & Whitney Division	Powdered Metal Consortium
Single Agreements	
General Motors Corporation, Saginaw Division	Case-Depth Determination in Steel Shafts

PARTNER*	SUBJECT
Ceramics	
Consortia	
Ceradyne Inc. Cincinnati Milacron, Inc. Corning Incorporated Dow Chemical Company Eaton Corporation Eonic Ford Motor Company General Electric Company General Motors Corporation, AC Rochester Division Norton Company SAC International Sonoscan, Inc. Stevens Institute of Technology Texas A&M University Torrington Company Tower Oil and Technology Company University of Maryland University of Rochester West Advanced Ceramics, Inc. W. R. Grace & Co.	Ceramics Machining Consortium
Single Agreements	
Akzo America, Inc.	Lubricants
American Society for Testing and Materials(2)	SRM's for Glass, Glass Ceramics and Related Materials
American Superconductor Corporation	Microstructural Modes of Failure of Bi2223-based HTS Composites
Carborundum Company, Inc.	Tribological Characterization of Ceramics
Digital Equipment Corporation	Tribology of Magnetic Recording

PARTNER*	SUBJECT
Dow Chemical Company	Materials Characterization Using Synchrotron Radiation
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, Inc.	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
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

PARTNER*	SUBJECT
General Electric Corporate Research and Development	Reaction Phase Separation Studies of Polymer Blends
	Transient Flow Phenomena in RTM Composite Preforms
Goodyear Tire & Rubber Company	Interaction Parameters of PI/PBD Blends
Grumman Aerospace Corporation	Resin Transfer Molding of Precursor Resins for Ceramic Matrix Composites
	Testing of Process Simulation Model for Resin Transfer Molding
International Business Machines Corp.	Polymers
Michigan Molecular Institute	Small Angle Neutron Scattering Study
National Center for Manufacturing Sciences, Inc.	Conduct Comprehensive State-of-the-Art Search
Rheology Research	Mechanical Properties of Polymeric Materials
Rohm and Haas Company Technical Assessment Systems, Inc.	Polymeric Microstructure 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	
Dentsply International, Inc.	Consortium for Development of Advanced Restorative Alloys
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
Creswell Scientific Products & Services	Barkhausen Signal Depth Profiling of Steel Shim Stock
Crucible Materials Corporation, Crucible Compaction Metals Division	Nitrogen Additions to Corrosion Resistant Metals
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

PARTNER*	SUBJECT
General Electric Company	Development of Scanning Ultrasonic Microscope (SAM) Techniques
General Inspection, Inc.	EMAT Inspection of Rods and Bars
General Motors Research Laboratories	Magnetocaloric Properties of Nanocomposite Materials
George Washington University	Modelling of the Noise Characteristics of Magnetic Recording Heads
GMW Associates	Testing of Iron Core Magnets of Special Design
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 (3)	Development of Computer Software for Corrosion Control
National Association of Corrosion Engineers	Materials Selection and Corrosion Prediction in Oil and Gas Ind.
National Center for Manufacturing Sciences	Development of Alternatives for Lead Based Solders
Olin Corporation	Measurement of Texture and Grain Size in Copper, Copper Alloys and Stainless Steel Sheet
Siemens Power Corporation	Absolute Measurement of Internal Pressure in Reactor Fuel Element Tubes
Sonimetrix, Inc.	Application of Cylinder Resonances to Stress Measurements

PARTNER*	SUBJECT
Sonix, Inc.	Acoustic Measurement of Stress in Microelectric Packaging
SPS Laboratories Nuclear Metals, Inc.	New Permanent Magnet Materials
Xerox Corporation Cornell University	Magnetic Nanocomposites as Powders, Coatings, Thin Films, and Monolithic Structures

Reactor Radiation

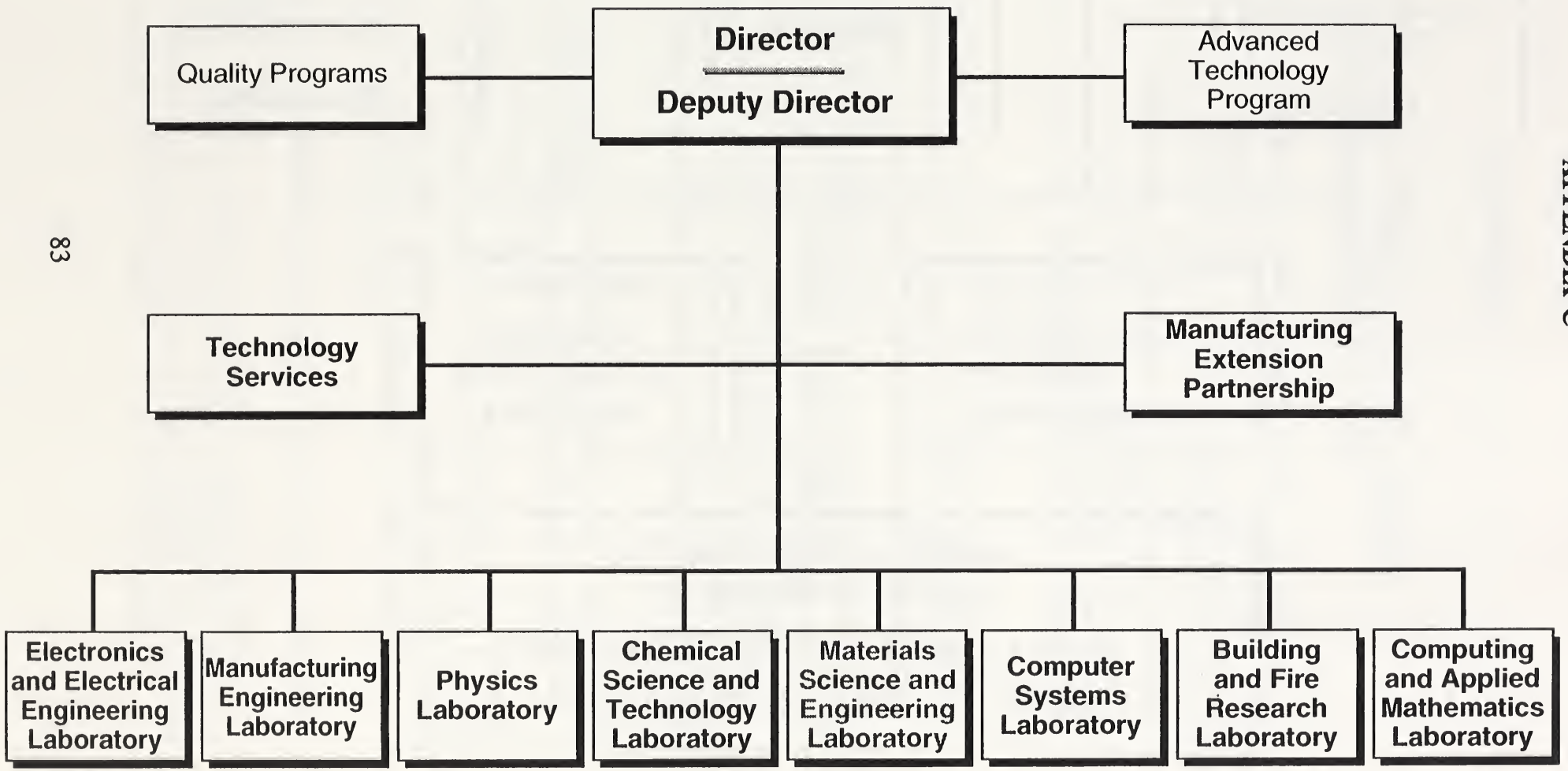
Single Agreements

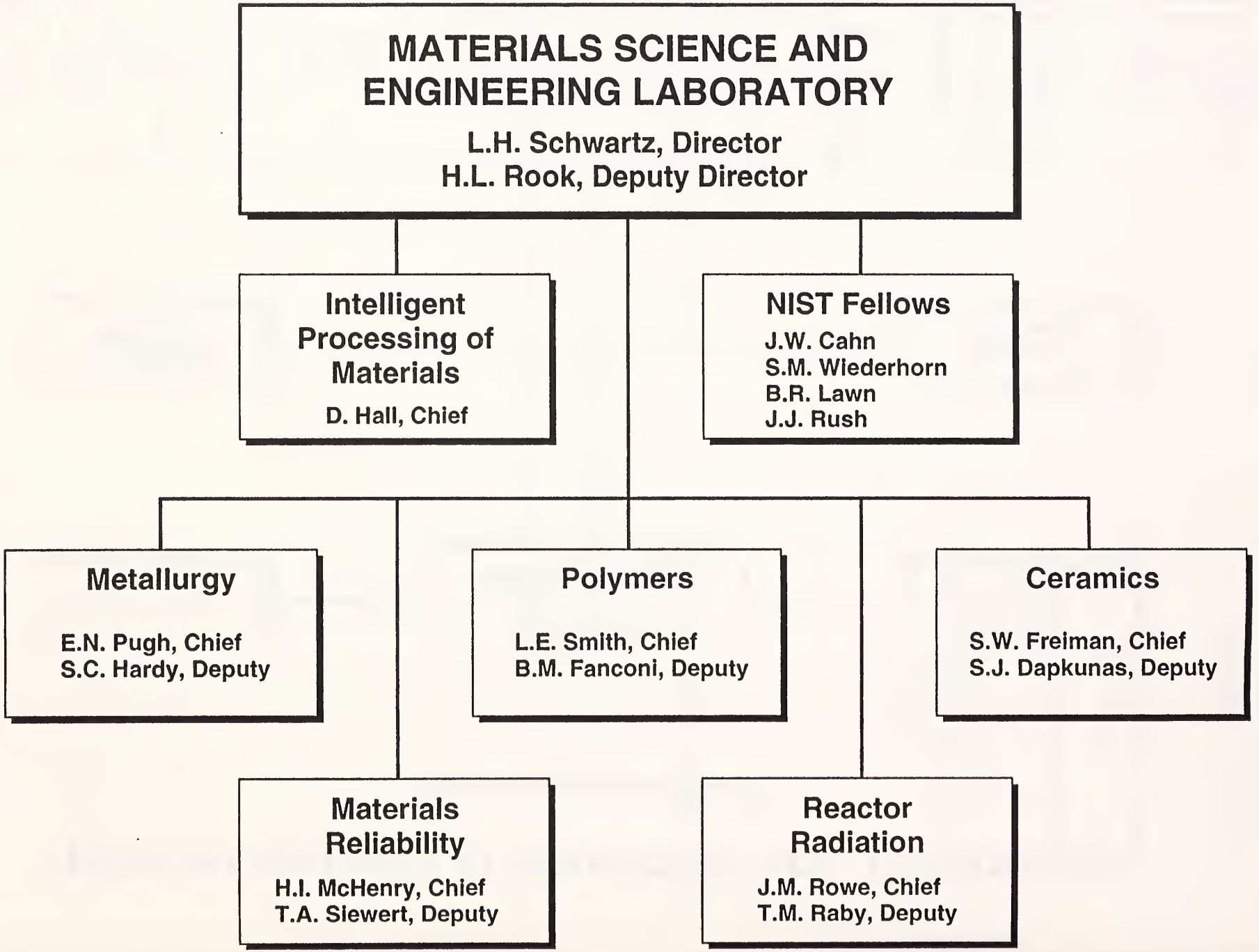
Texaco Research and Development	Small Angle Neutron Scattering from Complex Fluids

* Number in parenthesis indicates number of same subject agreements

National Institute of Standards and Technology

Organizational Chart

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H.L. Rook, Deputy Director
Intelligent Processing of Materials
D. Hall, Chief
NIST Fellows
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S.M. Wiederhorn
B.R. Lawn
J.J. Rush
Metallurgy
E.N. Pugh, Chief
S.C. Hardy, Deputy
Polymers
L.E. Smith, Chief
B.M. Fanconi, Deputy
Ceramics
S.W. Freiman, Chief
S.J. Dapkunas, Deputy
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H.I. McHenry, Chief
T.A. Siewert, Deputy
Reactor Radiation
J.M. Rowe, Chief
T.M. Raby, Deputy

APPENDIX E

RESPONSE TO PRIOR YEAR PANEL RECOMMENDATIONS

Recommendation: *"MSEL could increase its value to industry if more of its staff and frontline management had industrial experience."*
Response: Many MSEL staff and managers come to NIST with prior industrial experience. For example, the new Chief of the Office of Intelligent Processing of Materials and head of the MSEL Theory Center has fourteen years of industrial research experience in the metals and chemicals industries. The newly established NIST Industrial Fellows Program, under which NIST staff members may be assigned to work at industrial locations as guests, seeks to enhance first-hand experience by NIST staff with the industrial research, development, and operations environment.

Recommendation: *"Although the Ceramics Division does not have the resources to be involved in all aspects of ceramic processing and property characterization, it should consider expanding its research on ceramic powder forming, sintering and microstructure development, and electronic properties of bulk ceramics."*
Response: The Ceramics Division is carefully examining issues regarding processing and related properties of electronic ceramics. In particular, work has been initiated in collaboration with Trans-Tech, Inc. on the phase equilibria relations and properties of dielectric oxide ceramics for cellular communications. The Ceramics Division is collaborating with the Electromagnetic Fields and the Electromagnetic Technology Divisions in Boulder to measure the dielectric and magnetic properties of materials synthesized in the phase equilibria studies.

Recommendation: *" The panel supports the transfer of all nondestructive evaluation activity to the Materials Reliability Division in Boulder, Colorado, where the nondestructive evaluation application effort is currently located."*
Response: The transfer of George Alers and Ward Johnson has been completed. With the transfer the Division was given lead responsibility for the development of sensor systems for NDE and process control. NDE remains an important part of several projects in the various Divisions of MSEL. These activities will remain in Gaithersburg, but the Division plans to provide assistance in the area of sensor development.

Recommendation: *"Materials Reliability Division should continue its strong cooperative research with other organizations."*
Response: The Division has continued to expand its cooperative research with industry. In each project area we now have industrial partners who contribute to our research objectives while benefiting from our research results. In addition, we have strengthened our ties with universities, particularly by getting modeling support for our measurement program.

Recommendation: *"In intelligent processing, the [Materials Reliability] Division should place emphasis on automation procedures to start and stop weld process and on weld repair."*
Response: The Division recognizes this as an important new thrust for our research. We have identified spectroscopy as the best sensing approach to study arc behavior under the transient conditions associated with starting and stopping. We have purchased and conducted preliminary trials on the spectroscopy instrumentation, however, the research has been delayed due to CRADA commitments. One of the CRADAs is directed to the reduction of spatter through improved sensing and control. This research has included careful observation of starting and stopping because spatter is worse under these conditions.

Recommendation: *"The [Materials Reliability] Division's efforts in infrastructure materials should be expanded."*
Response: We have added one new project that is targeted to the infrastructure - "Global NDE of Bridges" - which uses ultrasonic stress measurements to monitor changes in load path due to structural damage. NIST's program in infrastructure materials, coordinated by the Building and Fire Research Laboratory (BFRL), are expanding and responsive to the plan delivered by the Civil Engineering Research Foundation (CERF). MSEL will play a role in this program, bringing our unique capabilities to those high priority areas defined by CERF.

Recommendation: *"The [Materials Reliability] Division should continue to reorient work away from cryogenic materials and should adopt a practical spray coating system with a few clearly defined, well-calibrated parameters."*
Response: The Division received sufficient funding from NASA and DOE to complete the cryogenic materials research that was underway in 1994 and to transfer unique measurement capabilities to other laboratories. This transition has been completed and no new funding will be accepted from NASA, DOE, or other agencies for cryogenic materials research in 1995. The second part of the recommendation is not relevant to any Division plans. Our work on ceramic coatings is to measure thermal conductivity of sprayed coatings prepared by industrial collaborators. We plan to continue to use samples processed in the spray coating systems of our collaborators.
Recommendation: *"The Polymers Division should continue to use its evaluation process to determine the appropriateness of program that support industrial sectors other than bulk polymer producers."*
Response: To evaluate and plan the Polymers Division program in electronic packaging and interconnects, Division personnel organized a May 1994 workshop co-sponsored by Semiconductor Research Corporation (SRC), Institute for Interconnecting and Packaging Electronic Circuits (IPC) and Optoelectronics Industry Development Association (OIDA) to assess the needs of the electronics industry for metrology and data in packaging and interconnects. Division staff also planned and participated in an industrial workshop that prioritized research needs in the health care industry related to total joint replacements. This information will be used to design collaborative research programs and plan for the Division's role in NIST-wide initiatives aimed at assistance to the health care industry.

Recommendation: *"The use of sensors for real-time process characterization should be considered for future efforts."*
Response: The Polymers Division has hired staff to develop sensors for real-time characterization of liquid molding processes. Application of infrared sensors to the cure process of preceramic polymers was made in an ARPA sponsored project involving AlliedSignal and Grumman Northrop who will adapt the sensors to their manufacturing processes.

Recommendation: *"...continuation of the Polymers Division Electronics Applications Group's overall program and encourages increased interaction with university centers and industrial consortia."*
Response: The Division works with the National Center for Manufacturing Sciences (NCMS) Printed Wiring Board Consortium to evaluate dimensional stability of next generation resins. Division staff serve as NIST representative on the Semiconductor Research Corporation (SRC) Packaging Technical Advisory Board in planning and review of SRC sponsored work at university centers, and as a member of the IPC Technology Roadmap Committee. Joint work has been initiated with SRC funded center at University of Texas, Austin on the effect of cure on moisture uptake in encapsulants.

Recommendation: *"The Polymer Composites Group is encouraged to collaborate with DOE laboratories pursuing advanced automotive projects."*
Response: Through the automotive Composites Consortium (ACC) the Polymers Division conducts durability studies in concert with activities at ORNL and Iowa National Laboratory.

Recommendation: *"...the Polymer Composites Group should concentrate on understanding and modeling processes as its industrial partners emphasize monitoring and control."*
Response: Modeling of liquid molding processing of an automotive part was delivered to the Automotive Composites Corporation (ACC) which utilizes the information to instrument the mold used to carry out full-scale fabrication. Also, in cooperation with the ACC, modeling of injection-compression molding, considered the next generation processing method, was initiated. The ACC will provide visualization monitoring of the process. Grumman Northrop uses the NIST mold filling model and understanding of the process to manufacture preceramic polymers.

Recommendation: *"Disseminate results on nonshrinking polymers outside the dental area..."*
Response: Polymers Division personnel presented seminars on non-shrinking polymers at Hercules and 3M; and duPont staff members have visited the Polymers Division to learn about these materials.

Recommendation: *"The panel stongly recommends that the Metallurgy Division strengthen its standards programs. Industry looks to NIST to provide this important function, without which the United States risks being kept out of international markets."*
Response: Division Management is in full agreement. In fiscal year 1995, the program to develop traceable National hardness standards was significantly expanded through the use of MSEL funds. The Laboratory is also cost sharing the program on thickness standards for electrodeposited coatings, and is considering new standards programs in electronic packaging and magnetic materials.

Recommendation: *"The panel again recommends that the Metallurgy Division implement its plan, proposed for several years, to use its expertise in atomization in the area of spray forming. The panel understands that suitable industrial partners are still available, but this window of opportunity will not remain open indefinitely."*
Response: A program was initiated in fiscal year 1995 to support a spray forming activity with Alcoa to produce Al alloy sheet and discussions are underway with the General Electric Company to collaborate in the area of plasma spray. In both cases, the MSEL role centers on the characterization of the atomization process.

Recommendation: *"The Metallurgy Division should maintain a strong sensing capability at the Gaithersburg, Maryland, site."*
Response: MSEL management strongly agrees with this recommendation. Thus the Metallurgy Division has made a permanent hire at the PhD level to maintain competence in eddy current sensing and has obtained additional support in this area via a contract with a local university. The application of sensing to the atomization process is also being strongly funded.

Recommendation: *"The Metallurgy Division must maintain a presence in corrosion research."*
Response: Division management agrees with this recommendation and with the related comment in the 1994 Assessment of Technical Programs that effort in this area be focused on mechanical aspects such as stress corrosion cracking and corrosion fatigue. The latter view was an important factor in the decision to combine the former Corrosion and Mechanical Properties and Performance Groups into a single group, the Materials Performance Group. This change was effective in October, 1994.

Recommendation: *"The Metallurgy Division should develop mechanisms for encouraging and rewarding development of management leadership from within its own ranks."*
Response: While no formal mechanisms have been developed, the division has been successful in encouraging able staff members to take leadership positions. In fiscal year 1995, two new Group Leaders were appointed from existing staff. Another Group Leader, previously recruited from within the division, is on a one-year assignment to the NIST program office, an activity which has become recognized as an important step in management training within MSEL.

Recommendation: *"A large number of key personnel in the Reactor Operations and Engineering group will be retiring between Spring 1994 and 1997, including the group chief, the operations chief, and the engineering chief. Also, the six most senior of the 17 licensed senior reactor operators will be eligible for retirement in this time frame, and most are expected to retire. The subpanel recommends that replacements be obtained sufficiently early in order to prepare them adequately and to ensure that the experience and knowledge of the retirees be adequately documented and transferred."*
Response: In FY94, the Reactor Radiation Division requested and received permission to increase personnel levels within the group during FY95, so as to allow overlap with retirees. During the current outage for maintenance, the next generation of supervisors were given supervisory responsibility, rather than the current supervisors, so that they would obtain hands-on experience with the systems being upgraded. The senior supervisors worked as part of the teams, so that their experience was available as needed. This has provided an excellent opportunity for information transfer. As soon as the reactor returns to operation, active recruitment of operators and managers will begin.

Recommendation: *"The subpanel recommends that the plan to relicense the NIST research reactor be endorsed by NIST management and that resources necessary to develop relicensing plans and to continually maintain and upgrade the entire reactor facility be made available. The CNRF has the most modern and advanced neutron scattering instruments in the United States. With the new cold source, it will be the nation's major center for cold neutron research until the Advanced Neutron Source (ANS) is constructed. In the unfortunate event that the ANS construction is delayed or canceled it is absolutely imperative that the NIST facility continue to operate for as long as possible.*
Response: During FY94, planning for reactor relicensing continued, and several initiatives important to the process were undertaken. Funds for the necessary improvements were provided for FY95, and permission for additional staff increases to allow overlap with retirees and for starting the relicensing process was granted. The appropriate regulatory officials were contacted to begin the process, and a plan to request a license extension in the near future, rather than to wait until the license expires to request a license renewal, was proposed. This plan will be actively pursued in FY95, beginning with a rewrite of the reactor Safety Analysis Report. In addition, all work being done during the present outage is being engineered and performed with the goal of thirty more years operation. A conceptual design team has been assembled to prepare plans for a renewal of all thermal neutron instruments over the next five years. Division Laboratory, and Institute management are committed to continued operation of the reactor facility over the next thirty years.

Recommendation: *"When the Advanced Neutron Source (ANS) is constructed, it will be the premier neutron source in the world. The task of ensuring the state-of-the-art instruments at this facility will require the cooperation of the entire neutron community. The subpanel recommends that RRD scientists take an active role in designing, constructing and using instruments to be installed at the ANS, thereby strengthening both the national and NIST programs in neutron scattering."*

Response: Reactor Radiation Division management has been strongly supportive of the ANS project, and Reactor Radiation Division representatives have participated in every ANS planning meeting and in all neutron scattering community enterprises. Unfortunately, as of the FY96 budget, the ANS has been terminated. However, Reactor Radiation Division staff fully intend to continue to actively participate in the construction or upgrade of any future neutron sources.