MRS BULLETIN

MATERIALS RESEARCH SOCIETY, VOL. VII NO. 1, JANUARY/FEBRUARY 1982

REPORT:

1981 ANNUAL MEETING

The Society's 1981 meeting, held at the Park Plaza in Boston, was a success. The purposeful move of the meeting date to the week of Nov. 15 achieved the desired result — it did not coincide with the first snow storm of the New England winter, although rain was noticed by those few participants who had time to leave the hotel.

Indeed, the program was compelling. All told, 14 symposia, a plenary session, and the Von Hippel Award ceremony served to occupy the 1371 attendees quite fully. Again, as has become customary, the meeting enjoyed international participation. Some 24 nations were represented, with major delegations from France (46); England (42), Japan (45), Canada (46), Germany (28), Sweden (11), and The Netherlands (9).

Participation at the meeting was not only large, but also quite active. Nearly 700 papers were presented, and the proceedings will comprise seven volumes in the MRS proceedings series, as well as two special issues of journals. As in the past, symposium proceedings will be published by North-Holland Science Publishers in New York. A summary of the meeting publication arrangements follows:

Laser and Electron Beam Interactions with Solids,
B. R. Appleton and G. K. Celler, editors, North-Holland, New York, April 1982.

Grain Boundaries in Semiconductors,
G. E. Pike, G. H. Seager and H. J. Leamy, editors, North-Holland, New York, May 1982.

Thin Films & Interfaces,
K. N. Tu and P. S. Ho, editors, North-Holland, New York, April 1982.

Scientific Basis for Nuclear Waste Management,
S. V. Topp, editor, North-Holland, New York, April 1982.

Metastable Materials Formation by Ion-Implantation,
S. T. Picraux and W. J. Choyke, editors.

Rapidly Solidified Amorphous and Crystalline Alloys,
B. H. Kear and B. C. Giessen, editors, North-Holland, New York, April 1982.

Materials Processing Research in the Reduced Gravity Environment of Space,
G. E. Rindone, editor, North-Holland, New York, May 1982.

Solid State Transducers
S. C. Chand and W. H. Ko, to appear as a special issue of *Sensors and Actuators.*

In Situ Composites,
Malcolm McLean, F. D. Lemkey and H. E. Cline, to appear in *Metallurgical Transactions.*

Members who were unable to attend the meeting may obtain summary abstracts of the entire program at nominal cost by inquiry with the secretariat:

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110 Materials Research Laboratory
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JAMES W. MAYER

1981 VON HIPPEL AWARD WINNER

John M. Poate (left) and Prof. James W. Mayer

The 1981 Von Hippel Award of the Materials Research Society was presented to Prof. James W. Mayer on Nov. 17 at the Boston meeting. Dr. John M. Poate, past president of the Society, presented the award, which consists of a $1,000 check and a plaque with mounted ruby crystal, and gave a short biographical sketch. Mayer attended Evanston, Ill., Township High School, and graduated from Purdue University in mechanical engineering in 1952. He then spent two years in the Army before returning to the Physics Department at Purdue for graduate studies. His Ph.D. (1960) dissertation work was on the response of surface barrier detectors to ionizing radiation and was carried out under the supervision of Professor K. Lark-Horowitz. This was an exciting and important time in the development of solid-state detectors. In fact, Mayer was the first to demonstrate that a surface barrier detector gives a linear response to α-particle irradiation.

Mayer was with Hughes Aircraft Company from 1959 to 1967 and carried out research on detectors and ion implantation. During this time he obtained the first patent on the use of Lithium-drifted detectors for spectrometers. He was also, from 1965 to 1967, engaged in studying ion implantation phenomena by Rutherford backscattering and channeling techniques at Chalk River, Canada.

Mayer was professor of electrical engineering at Caltech from 1967 to 1980, where his research interest centered on particle-solid interactions and thin film reactions covering such topics as implantation, ion-beam mixing, silicide formation and epitaxial growth of semiconductors (thermal and laser annealing).

He was appointed Francis Norwood Bard Professor of Materials Science and Engineering at Cornell University in 1980 and is currently engaged in creating a new tandem accelerator laboratory to pursue his research. Mayer has had a profound influence on the development of modern material science with particular emphasis on semiconductor materials. Almost every area he has worked in has turned out to be important. For example, his research on implantation identified the damage and epitaxial regrowth phenomena long before the technique was accepted as an integral part of the semiconductor industry. He has been a pioneer in the use of ion beam techniques for materials analysis.

Mayer has coauthored six books and has published over three hundred papers. He is a fellow of the American Physical Society and IEEE and a member of the Bohmische Physical Society.

Prof. Mayer has always taken a strong interest in the well-being of students and colleagues. He was Master of Students at Caltech from 1975 to 1980 and scuba instructor from 1970 to 1980. His wife, Betty and five children have always participated in his research activities and have fed and boarded an astonishingly large number of colleagues. Betty is assistant professor at the Campus School, State University of New York.

Mayer gave a thirty-minute address at the awards ceremony entitled "Conflict or Collaboration: Materials Science in University and Industry." He pursued two broad themes. First he showed with examples from his own research what an exciting time it is to be involved in materials. Secondly, he discussed the more sobering aspects of scientific funding and emphasized the importance of university-industry collaboration in tackling the more expensive research projects.

[Editor's note: Highlights of Prof. Mayer's address will be presented in the next issue of the Bulletin.]

W. CONYERS HERRING

1980

W. Conyers Herring is professor of applied physics at Stanford University. He has had a seminal influence on materials science and solid state physics, contributing to the understanding of solid surfaces that underpins the fields of crystal growth, sintering and plastic flow at high temperatures. Together with J. K. Galt he realized and demonstrated that whiskers of high crystalline perfection would exhibit extraordinary mechanical properties.

Prof. Herring received his Ph.D. in physics from Princeton in 1937. He taught at MIT, Princeton and the University of Missouri, and from 1941 to 1945 was a member of the War Research staff at Columbia University. After 30 years of service at Bell Laboratories, he joined Stanford in 1976.

DAVID TURNBULL

1979

David Turnbull has been Gordon McKay Professor of Applied Physics at Harvard since 1962. A physical chemist by training, Professor Turnbull's research has encompased a broad range: thermionic emission, thermodynamic properties of gases at high pressures, corrosion in non-aqueous media, diffusion in metals, kinetics of nucleation in solid state transformation, solidification, theory of liquid and glass.

Dr. Turnbull received his Ph.D. in physical chemistry from the University of Illinois in 1939. He began his career as a teacher at Case Institute of Technology, then joined the research laboratory of the General Electric Company in 1946, where he remained until he joined the Harvard faculty.

W. O. BAKER

1978

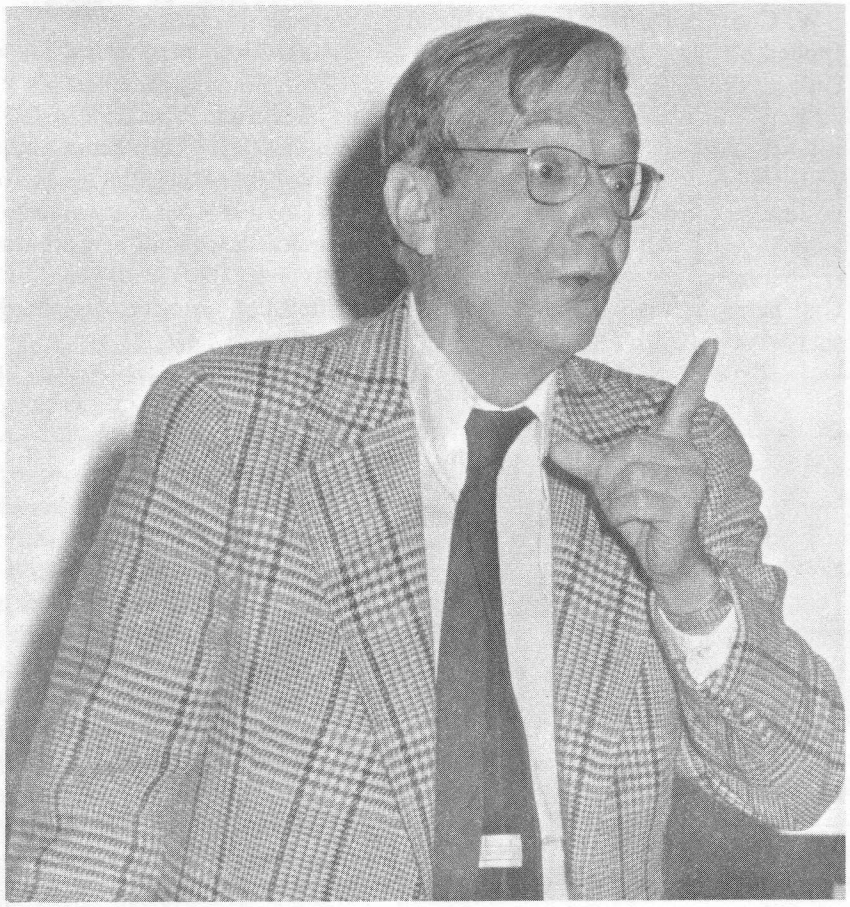
W. O. Baker joined Bell Laboratories in 1939 as a member of the technical staff, rising steadily to become its president in 1973. Despite a rigorous schedule of research into solid state materials and macromolecules, dielectric and dynamic mechanical properties of crystals and glasses, information processing technology, and plastics, fibers and natural and synthetic rubbers, he has long devoted himself to numerous civic, governmental and scientific committees and commissions.

Dr. Baker received his Ph.D. in physical chemistry from Princeton in 1938, having taken his undergraduate training at Washington College. Washington awarded him its honorary Doctor of Science degree in 1957; at last count, seventeen other institutions brought honor to themselves with similar awards.

ARTHUR VON HIPPEL

It was the pioneering research, and the unfettered spirit, of Arthur Robert Von Hippel that led the Society to create the award which bears his name. Emeritus Professor of the Massachusetts Institute of Technology, Dr. Von Hippel's research into dielectrics, semiconductors, ferromagnetics and ferroelectrics resulted in the publication of two visionary books, *Molecular Science and Molecular Engineering* and *Molecular Designing of Materials and Devices*.

Von Hippel studied electrophysics at the University of Goettingen, which granted him the Ph.D. in 1924. After a decade of teaching and research in Europe he joined the faculty of MIT in 1936. It was in his lab that his vision of scientists working cooperatively to solve the mysteries of materials from the atomic to the microstructural level first challenged the parochialism that had prevailed before and demonstrated the utility of the interdisciplinary approach that the Society hopes to foster and embody.



Professor N. Bloembergen

LASER AND ELEC
INTERACTIONS W

The symposium consisted of nine half-day sessions and a late-news poster session in four days, during which 18 invited and 89 contributed papers were presented, along with 21 posters, for a total of 128 presentations. Authors represented 34 American and 33 foreign institutions. Thirteen foreign nations were represented with a total of 44 papers. Attendance topped 400 people.

The symposium attracted prominent scientists from around the world including the 1981 Nobel Laureate in Physics, Prof. N. Bloembergen from Harvard University, who gave the opening paper. Papers at the conference addressed topics ranging from the very fundamental aspects of laser, electron and ion beam interactions with solids to applications of these non-equilibrium processing techniques for the fabrication of semiconductor devices and the alteration of the materials properties of metal and insulators.

A significant fundamental question concerning the state of silicon following the absorption of short (10^{-7} to 10^{-11} S), intense laser pulses was settled in the opening session. Previous symposia in this series have been concerned with whether absorption of the energy from the laser pulse into the electronic system of the semiconductor is transferred quickly to phonons (lattice vibrations) and thus leads to melting of the near surface; or whether the absorbed energy remains in the electronic system in the form of a hot, dense plasma but the lattice temperature remains cool, as proposed by J. A. Van Vechten (IBM). Prof. Bloembergen and his co-workers presented convincing evidence from measurements of charged particle emissions, thermally assisted photo-emission, time- and space-resolved reflectivity and phase changes, that the energy transfer to phonons was rapid and that the surface melts. B. C. Larson (ORNL) presented nanosecond-resolution, synchrotron X-ray measurements of the near-surface structure of silicon during the laser pulse which showed that melting occurred. J. C. Phillips (Bell Laboratories) presented the microstructural limitations of the two models, and in general a variety of time- and space-resolved studies were presented in regular and late-news sessions which left little doubt that the thermal melting model is the correct physical process.

The extremely rapid melting and recrystallization rates possible with these new techniques have lead to new insights into a number of fundamental crystal growth and rapid solidification phenomena. J. M. Poate (Bell Laboratories) and C. W. White (ORNL) investigated rapid,

TRON BEAM ITH SOLIDS

non-equilibrium crystal growth phenomena using pulsed lasers, and com ter modeling calculations of thes apid solidification effects were presented by P. Baeri (Catania, Italy). A. G. Cullis (RSRE, England) and J. Narayan (ORNL) presented results on phase transformations, defects and interfacial instability effects at these rapidly moving interfaces, and N. M. Johnson (Xerox) discussed electronic defects.

A joint session with the symposium on Metastable Materials Formation by Ion Implantation compared the effects of laser processing with those produced by ion bombardment. Significant insights into quenching aspects and metastable materials formation were provided in invited talks given by S. Stritzker (KFA, Jülich, Germany), D. M. Follstaedt (Sandia), and J. E. E. Baglin (IBM).

B. R. Appleton
Oak Ridge National Laboratory

G. K. Celler
Bell boratories
Cha men

MAGNETIC AND OPTICAL MATERIALS FOR INFORMATION STORAGE

Thirteen papers were presented at the Symposium on Magnetic and Optical Materials for Information Storage, covering new materials for recording heads, magnetic media, and optical disk data storage. Two new media for optical disks were detailed and critical analyses of existing materials were presented.

A necessary criterion for any optical recording medium is sensitivity sufficient to "write" at existing laser powers and wavelengths. But in some media, such as thin films of tellurium, high sensitivity brings a corresponding sacrifice of long term stability. This was clearly demonstrated in the report by E. LaBudde, which documented degradation in thin Te films under accelerated aging conditions. Several new media reported at the meeting do not suffer this corrosive degradation.

The earliest media recorded by ablation, a mechanism in which a pit is melted or vaporized by the laser spot. Ahn and coworkers from IBM described media based on amorphous films of noble metals and silicon. When heated by the laser "write" pulse, these sandwich films devitrify to form a crystalline silicide which differs in reflectivity from the unwritten background. Differences in reflectivity are sensed and read-out by a second optical beam.

Quite another approach to media was presented by R. E. Howard and H. G. Craighead of Bell Labs. They textured Si or Ge into submicron columnar structures by reactive ion etching. A write pulse melts the columns locally, creating a reflective spot. Read-out is based on the difference in reflectivity between the spot and the light-trapping columns.

Both the BTL and IBM media show promise of good archival stability in tests reported by their inventors.

But, as Alan Bell pointed out in his review, sensitivity and archivality are only two of the necessary features of an optical recording material. It must have low optical noise and a raw bit error rate of $<10^{-5}$ plus the feasibility of being fabricated at an acceptable cost.

The competition for optical disks is of course, magnetic media. In his keynote address, D. Speliotis clearly showed that magnetic recording has a long history of increasing bit densities and decreasing cost per bit. He emphasized that the implementation of vertical recording in which the easy axis of magnetization is perpendicular to the disk can give bit densities of 10^4 per cm. Still needed are improvements in materials beyond the present rate earth-transition metal magnetic alloys and thin film head materials.

A lively panel discussion at the close of the session brought forward many of the current issues facing this fast-emerging, materials-sensitive technology.

Theodore Davidson
Xerox Corporation
Chairman

On these pages appear brief reports by chairmen of some of the 1981 Annual Meeting symposia. Space does not permit all of the symposia highlights to appear in this issue of the Bulletin, and more reports will be published in the March-April issue.

CONFERENCE ON IN SITU COMPOSITES

The fourth Conference on *In Situ* Composites attracted thirty contributed and invited papers, in which were examined and discussed new findings and technologically significant developments emerging from studies of directionally transformed materials. A fewer number of papers were presented, compared with previous conferences, on the high temperature structural eutectic alloys for gas turbine applications. The eutectic superalloys, NiTac-14B and $\gamma/\gamma'+Cr_3C_2$, are currently undergoing turbine blade/vane casting trials after extensive mechanical property evaluations and will be engine tested during 1982 and 1983. Significant progress in achieving improved transverse ductility in NiTac-14B and scale up to complex shapes through commercial casting houses were reported by GECR&D and NPL respectively.

The growth, coarsening and complex stress distribution existing between fibers and lamellae in aligned eutectics were examined using *in situ* transmission electron microscopy by French researchers at Grenoble. Changes in lamellar spacing, fault nucleation and coarsening in a thermal gradient were graphically captured in movies taken off the 1 MeV electron microscope.

Progress on non-structural applications of *in situ* composites continues with the integrated circuit construction and further sophistication of field emitters by Georgia Tech researchers with emphasis on increases in current density and life of the arrays. Fault free eutectic thin-films (~200Å) thick were produced at GECR&D using evaporated layers on glass slides and laser heat sources. An exciting novel technique to produce *in situ* composites by mechanical means from cast dendritic structures was described by Verhoeven and Bevk. Research under these professors at Iowa State and Harvard University produced Cu-Nb+Sn filamentary composites by wire drawing techniques with varying volume fractions which had outstanding superconducting properties. In composites with the smallest filaments (d~50–200Å) and filament densities as high as $10^{10}/cm^2$, the dislocation density in the matrix reaches values of $10^{13}cm/cm^3$. The yield stress of these samples increases dramatically over the predictions based on the "rule of mixtures" and their ultimate tensile strength approaches the estimated theoretical strength of the material (~2.7GPa).

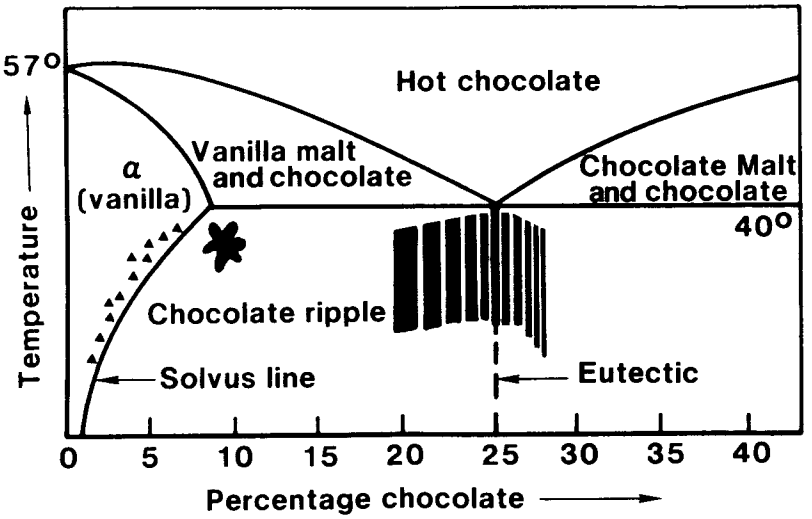
Discussions on the chocolate-vanilla phase diagram (below) continued over lunch and dinner with variations in bubble diagrams in beer.

Malcolm McLean
National Physical Laboratory
England

F. D. Lemkey
United Technologies
Research Center

H. E. Cline
General Electric
Research and Development
Chairmen

The Chocolate-Vanilla Phase Diagram



BERLIN, 1982

The Society's Fifth International Symposium on the Scientific Basis for Radioactive Waste Management will be held in Berlin, West Germany, June 7-10. It is co-sponsored by the European Nuclear Society and Kerntechnische Gellschaft, and organized by the Hahn-Meitner-Institut fuer Kernforschung Berlin GmbH.

The meeting, which succeeds the fourth symposium held at the 1981 Annual Meeting, will focus on the science underlying waste forms (vitreous, ceramic, spent fuel, cement), waste isolation (container materials, backfill, repository) and modeling and safety assessment. Waste forms are restricted to those than contain HLW or transuranic elements.

The Society's symposia are singular in their concern with the basic science-rather than the engineering, technical or political-issues involved in nuclear waste management.

For more information contact Program Chairman Dr. W. Lutze, Hahn-Meitner-Institut, Glienicker Strasse 100, Berlin 39 D1000, West Germany. His telephone number is 49-308-0091.

THE BULLETIN NEEDS YOUR HELP

Lacking a network of correspondents, the MRS Bulletin needs your participation if it is to serve the Society by publishing news of interest to the membership. Specifically, we would like to receive:

Reviews of research. These should be brief, no more than about four typewritten (doubled spaced) pages if accompanied with an illustration, or about six pages if no illustration is included.

Letters. These should likewise be brief. The affiliation of the author is important.

News Items of general interst.

Personnel news, such as promotions, transfers, new staff members, awards and honors. A "head shot" (portrait) of the individual is welcome.

Photographs of general interest. Photos should be black and white, glossy, 8 inch by 10 inch; slides and color prints are generally unusable.

Obituaries of colleagues who are materials scientists. The subject's photograph and professional and personal history are of particular interest.

Whimsy.

Employment information, from those offering jobs or those who want them.

Submissions should be sent to the Editor, Materials Research Society Bulletin, Box 1334, Summit, N.J. 07901, except for Reviews, which should be addressed to H. J. Leamy, Bell Laboratories, Murray Hill, N.J. 07974.

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GRADUATE STUDENT AWARDS

Five outstanding graduate scientists were honored with the Society's Student Awards during the Von Hippel Award ceremony, in recognition of participation in meeting symposia, outstanding performance as judged by faculty advisers, and significant research as judged by the Awards Committee.

The award winners, who received a transportation grant and cash award, their institutions, discipline, paper title and symposium are:

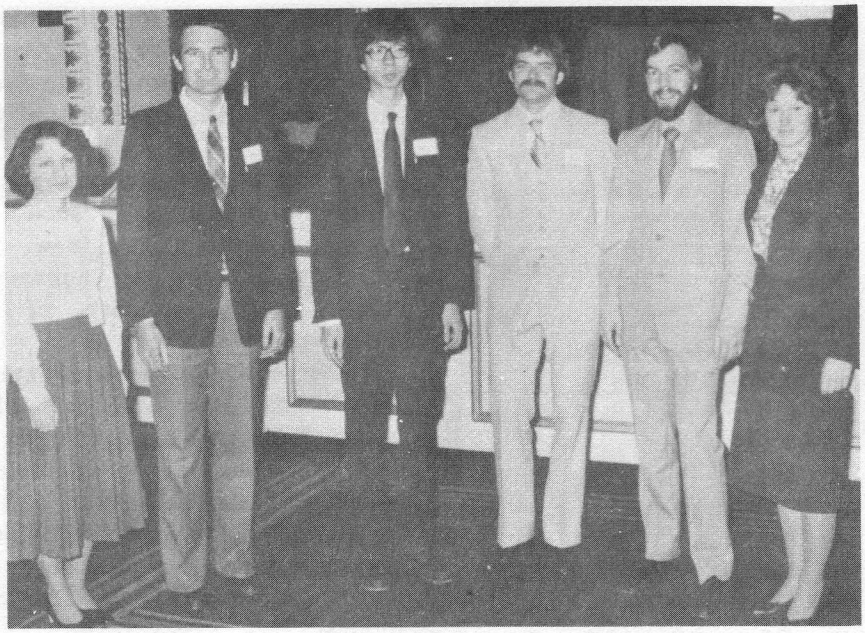
Richard N. Grugel, Michigan Technological University, metallurgy, "Selective Etching and Laser Melting Studies of Monotectic Composite Structures", *In Situ* Composites.

Clement Lemaignan, Republique Francaise Commissariat a l'Energie Atomique, metallurgy, "*In Situ* Electron Microscopy of Solidifying Metallic Putectic Alloys", *In Situ* Composites

Grant Lu, Rutgers University, ceramic engineering, "Directional Crystallization in Potassium Silicate Glass-ceramics", *In Situ* Composites.

Charles A. Parker, Massachusetts Institute of Technology, metallurgy, "Incubation Times and Size Distributions for He-vacancy Clusters in Several Fe-based Alloys: II. Theory", Microscopy and Chemical Analysis of Segregation and Clustering in Crystalline Solids.

Marina Rose Pascucci, Case Western Reserve University, ceramics, "Study of the Metamict Transformation in α-quartz Using High Resolution Lattice Imaging and Convergent Beam Electron Diffraction", Scientific Basis f Nuclear Waste Management.



STUDENT WINNERS (left to right) Marina Rose Pasucci, Clement Lemaignan, Grant Lu, Richard N. Grugel, Charles A. Parker, and Society Treasurer K. C. Taylor