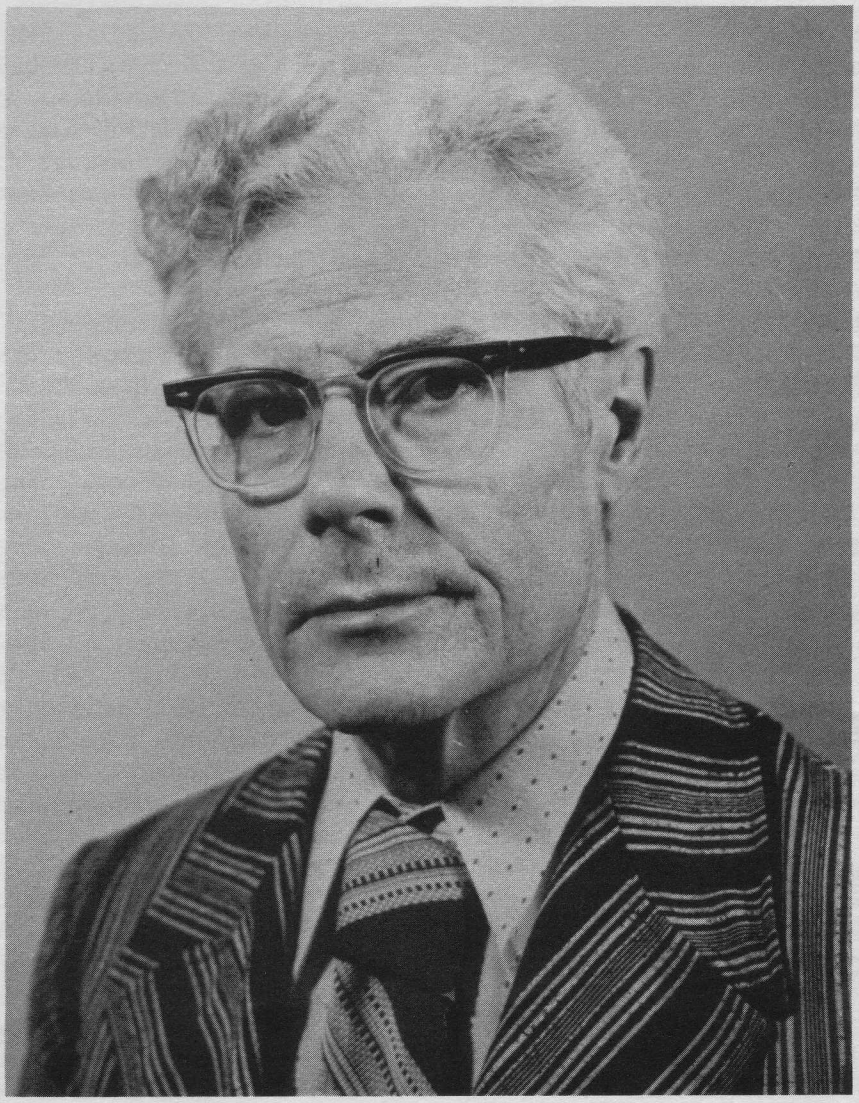
NEWSLETTER

JULY 1980

Materials Research Society

CONTENTS

TURNBULL RECEIVES VON HIPPEL AWARD



David Turnbull, 1979 recipient of the Materials Research Society Von Hippel Award recognizing outstanding service to Materials Research, November 27, 1979. (Text of Dr. Turnbull's acceptance speech begins on page 2).

1979 ANNUAL MEETING SUMMARY

The 1979 Annual Meeting at the Hyatt Regency Hotel in Boston was eminently successful, drawing 944 registrants. The Von Hippel Award was presented to Professor David Turnbull of Harvard University for his outstanding contributions to Materials Science.

The total number of symposia was 13. Some of the larger symposia, such as Scientific Basis for Nuclear Waste Management and Laser and Electron Beam Processing of Materials, are now clearly recognized as the premier international meetings in these disciplines. The smaller symposia were well attended and reflect the Society's ability to sponsor and develop important emerging areas of Materials Science. Chairpersons and organizers are to be congratulated for an outstanding meeting.

ACCEPTANCE REMARKS FOR THE VON HIPPEL AWARD OF THE MATERIALS RESEARCH SOCIETY, HYATT REGENCY HOTEL, BOSTON, MASSACHUSETTS - NOVEMBER 27, 1979

SOME THOUGHTS ON DIRECTIONS IN MATERIALS SCIENCE

David Turnbull, Division of Applied Sciences, Harvard University*

It is a high honor to receive this award; especially so, considering the distinction of the first two recipients: Professor von Hippel, who pioneered brilliantly in the development and definition of Materials Science, and Dr. Baker, under whose leadership were made the great scientific and technological discoveries at Bell Laboratories during the past decades. It is not clear to me that I belong in this progression. I feel that I am in a position rather like that of a certain Linus. I'm sure that you all know of two famous persons named Linus but you may not have heard of the Linus to whom I refer. He was identified by the ecclesiastical historian Eusebius as the first Bishop of Rome following the Apostles Peter and Paul. In any event, this award indicates that some of my colleagues, rightly or wrongly, think highly of me and that is pleasant to know.

When Ken Jackson told me of the award he said that on the occasion of it I should present a talk. I thought that I might base the talk on the research of my associates and myself on the mechanism of crystal growth in covalent systems. However, Ken tactfully informed me that so technical a topic would not be quite appropriate. Instead, I should attempt something rather more cosmic or, at least, amusing. What follows will be some highly personal, and rather disjointed views on where Materials Science is, how it got where it is and where it may be going.

It seems logical that Materials Science begin where conventional Chemistry ends. That is, it would be the science of characterizing, synthesizing and explaining ultramolecular structures. Such a definition is tidy for a dictionary but it is, perhaps, overly inclusive in that it intrudes on a number of already well developed and organized disciplines. More realistically, Materials Science is the science of the more complex features of the structure and behavior of real solids; especially those features which depend critically on the various structural imperfections - surfaces, internal boundaries, point and line defects - sometimes in thermodynamic equilibrium but more often in configurationally frozen states. The especial forte of the Materials Scientist is in determining the basic components of complex structures, how they act to produce the structures' responses to applied forces and thermal treatments and in synthesizing new materials which may exhibit unique responses.

Indeed, the main preoccupations in solid state science have, I think, progressed

* Since 1962 Dr. Turnbull has been Gordon McKay Professor of Applied Physics at Harvard University, coming to Harvard from General Electric Research Labs, Schenectady, N. Y.

historically from the simpler and highly ordered toward every more disordered and complex materials. Naturally, the early activity centered on the properties of ideal crystals and later on thermally excited oscillations within these crystals. When in the early part of this century, the theories for ideal crystals had been fairly well developed it became clear that certin of the most important properties of solids - especially the transport and mechanical - could not possibly be accounted for by ideal crystal models. This realization triggered the invention of point and, later, line imperfections and their corollary models for transport and mechanical behavior. It is remarkable that these models generally achieved success by requiring that no more than one atom in a million be displaced from its ideal crystalline position. Such small deviations from structural regularity were aptly labeled "imperfections in nearly perfect crystals". As we know, the predictions of the models on the nature, density and function of the imperfections were to a remarkable degree confirmed by ingenious experimental studies in various laboratories during the late forties and early fifties. There have been, I think, few, if any, precedents where models of such complexity were so thoroughly vindicated by experience.

It has seemed to many in my generation that this whole historical phase was the golden era of Materials Science and I would like to dwell on it a bit. It was marked by a very strong impact of fundamental on applied science - which had always to be empirically concerned with complex and disordered systems - and one of its most notable features was a highly effective interdisciplinary interaction between physicists, chemists and certain groups of applied scientists. How a climate so favorable for such interdisciplinary discourse and cooperation developed is a fascinating historical problem. I think that two of the important factors in the development were the holistic training and outlook of some of the leading physicists of the period and the unusual receptivity of certain applied science groups, especially the metallurgical, to basic science.

One of the most striking manifestations of the metallurgists receptivity were the seminars initiated in the late 1940's by one of the most applications oriented of technical societies, the American Society of Metals. At these seminars several hundred metallurgiests - students, teachers and technologists - assembled on the weekend prior to the Metals Congress to hear expositions by such leading solid state physicists as Clarence Zener, Frederick Seitz, Conyers Herring, Charles Frank, Harvey Brooks and John Slater as well as by eminent metallurgists such as Cyril Smith, Lawrence Darken and others.

Perhaps the metallurgists' enthusiasm for basic science was partly due to the outstanding successes of thermodynamics and X-ray metallography when applied to metal processing and alloy development. Leading physicists may have become impressed with the importance and potential of Materials Science from their World War II experiences where a concerted use of various disciplines, basic and applied, was crucial to the success of certain of the major projects. Also following World War II leaders of the high technology laboratories recognized that further improvements of high performance electrical and mechanical devices might be materials limited. This realization stimulated the formation of interdisciplinary industrial research groups which played leading roles in the advancement as well as in the definition of Materials Science.

In the more recent past the center of activity in Materials Science has seemed to shift toward still more disordered systems; indeed, to solids so disordered, e.g. glasses and concentrated alloys, that they are very far removed from the "nearly perfect crystals" category. Of course, many materials in these classes have long been known and used. What is new is the emphasis on the synthesis of unique new disordered materials and more concerted efforts to understand their structure and behavior at the fundamental level.

Under ambient conditions most of the solids we study and actually use are in non-equilibrium configurationally frozen

states. However, in terms of configurations or calories these frozen states are not far removed from equilibrium. In contrast, the new disordered materials - amorphous metals and semiconductors, microcrystalline solids and heavily supersaturated solutions - are in configurationally frozen states which are generally very far removed from equilibrium. Their syntheses, which are prominently featured in this conference, were achieved by exploitation of techniques such as ultra-rapid melt-quenching, ion sputtering, ion implantation and laser annealing. The general approach in all these methods is to create highly metastable configurations and then immobilize them as quickly as possible. An alternative approach, which I have favored, is to bring the system into a metastable state after heterophase nucleants have been, as far as possible, eliminated and then immobilize slowly. This method has had some modest successes, when homophase nucleation was inappreciable, and could, I think, be more widely exploited. By whatever method they are formed, the variety in structure composition and behavior of these new materials is so rich that they are likely to challenge and engage Materials Scientists for a long time to come. We should see, for example much more use of the new techniques in the synthesis of new ceramic materials.

Now, as I rashly promised, I will try to guess what may happen next. It is always safe to predict that one of the major future frontiers will be surface and interface science. Various panels of experts have been saying this at regular intervals for decades. Actually, one of my early recommendations, thirty years ago, to G.E. Management was that fundamental studies of surfaces be reinstituted so that we might better understand heterogeneous catalysis and corrosion. Irving Langmuir must surely have made a similar recommendation to, Willis, Whitney, his director, three decades earlier. All this means that the problem of surfaces and interfaces is a very tough one, and this is not surprising considering that, typically, only one part in several million of the mass of a system is likely to be found in the interfacial regions. However, there are procedures for achieving very high interfacial densities in solids and such solids are exhibiting some striking and unexpected behavior. Also, some new high resolution techniques are being applied very effectively in surface studies. At the present rate of progress there is hope that, in the next decade, the surface problem can be removed from the critical list.

We might expect that the historical trend toward preoccupation with ever more disordered systems will simply continue but there is the problem how much more disordered can solids get. Actually, there is a class of complex materials which has been largely overlooked by Materials Scientists. These are the organic condensed systems, including polymeric and biological structures. Of course, they have not been wholly neglected and some have exhibited quite fascinating mechanical and electrical behavior. It is highly possible that these materials will come to attract a much larger share of attention than they now do.

In discussions of future directions there are those who remind us, often with good reason, that many of the old problems, even concerning ideal crystals, have not really been solved. However, such views often are swamped by the acclaim to those, who with whatever knowledge they had, pushed on to the discovery of new materials and phenomena.

In contrast, there are those who tell us from time to time that all the important problems in a field have, in principle, been solved and the field is therefore dead. So we were told by some of our solid state colleagues following the major developments of the "nearly perfect crystal" era. Yet here we all are, learning about and discussing materials - glassy metals and semiconductors, ion implanted solids - and new techniques for producing them, which were almost unheard of twenty-five years ago. Perhaps the one safe prediction is that ten or fifteen years from now there will be a conference similar to this one where many young enthusiasts, too naive to realize that all the important discoveries had been made, will be describing materials and processes that we, at present, have no inkling of.

MRS COUNCIL MEETING

A meeting of the MRS Council was hosted by K. N. Tu at IBM Research, Yorktown Heights, N. Y., on Wednesday, March 19. Many issues were discussed and the following substantive motions were adopted:

1) The Society has signed an agreement with Elsevier-North Holland to publish MRS proceedings under a unified format. At least three of this year's symposia will be published as separate volumes under MRS sponsorship. The Society anticipates that this series will be an important addition to the Materials Science literature.

2) A committee was formed to enlist more corporate sponsorship to insure that the Society's finances rest on a sound foundation. R. J. H. Voorhoeve (Celanese Cor.) will chair the committee and E. N. Kaufmann Bell Labs) will be Vice-Chairman.

3) A student award program was adopted. (See related article, p. 5).

The Council discussed at length cooperation with the American Physical Society (APS). (See related article which follows.) In general, while the Council was enthusiastic about ties with the APS, an APS proposal to run a joint MRS-APS meeting on the East Coast in 1981 was not adopted. It was felt that the Society would lose some of its identity in a large joint meeting. However it was felt that there were obvious benefit to sponsoring individual joint symposia, and the APS-MRS will run a joint symposium in 1981 on Ion-Implantation.

COOPERATION BETWEEN MATERIALS RESEARCH SOCIETY AND AMERICAN PHYSICAL SOCIETY

On January 11, 1978 discussions were held between representatives of the Materials Research Society (J. M. Poate, K. A. Jackson and R. J. H. Voorhoeve) and the Committee on Applications of Physics of APS (CAP). The purpose of the meeting was to explore ways in which the two Societies can cooperate in their efforts to serve those of us who apply physics in the characterization, processing and application of materials. Since the Materials Research Society serves a wide spectrum of scientists with backgrounds in a large number of different disciplines, it is useful to weave collaborative patterns with discipline-oriented societies such as APS.

At the meeting, it was agreed that we should strive towards coordination of topical meetings and mutual assistance in organizing the best possible forums for materials science. The CAP unit of APS recognizes that recent MRS meetings have been highly successful and illustrative of the type of meetings in which they believe many physicists would like to participate.

Concrete steps towards cooperation and coordination include a symposium on ion-implantation scheduled for the 1981 MRS meeting in Boston, to be co-sponsored by the CAP group of APS. Also, announcements of topical symposia to be held at the 1980 MRS meeting in Boston will be published in the APS Bulletin.

MATERIALS RESEARCH SOCIETY ANNUAL MEETING AWARDS FOR GRADUATE STUDENTS

The Materials Research Society announces the availability of ten awards for graduate students conducting research on a topic to be addressed in the several symposia planned for the 1980 annual meeting. Each award will consist of a cash grant of $50, to be presented at the Von Hippel Award ceremony during the meeting, a waiver of the registration fee, and a travel grant amounting ton one-half the price of economy round-trip air fare from the student's community to Boston, MA, the site of the 1980 meeting.

Criteria for selection are:

1. Graduate standing in a recognized academic program in either materials science, metallurgy, ceramics, or polymers; physics or chemistry; geology or mineral science; electrical, civil, mechanical, mining or nuclear engineering; or other materials-related field.
2. Participation in a research project dealing with one of the following symposium topics:
   a. Laser-Solid Interation
   b. Defects in Semiconductor
   c. Semiconductor Interfaces
   d. Nuclear Waste Management
   e. Photo-Thermal Materials
   f. Electron Microscopic Imaging
   g. Spectroscopic Characterization of Heterogeneous Catalysts
   h. Catalyst Supports and Support Effects
   i. Hydrogen at Surfaces and Interfaces
   j. Nuclear and Electron Resonance Spectroscopies Applied to Materials Science
   k. Magnetic and Optical Materials for Information Storage
   l. Advances in Cement-Matrix Composites
   m. Synthetic Modulated Materials
3. Outstanding performance in the conduct of this project and promise for future substantial achievement in materials research as judged by the faculty advisor.
4. Significant and timely research results, as judged by the chairman of the appropriate symposium.

Application materials required are:

1. Application form, obtained by writing to:
   Secretariat
   Materials Research Society
   102C Materials Research Laboratory
   University Park, PA 16802
2. Abstract of relevant thesis or publication.
3. Letter of support from research supervisor, to be sent to above address.

Deadline for completed applications is September 1, 1980. Results will be announced on October 1.

NOTES ON 1980 MRS MEETING

A series of interdisciplinary, topical symposia will be held at the annual Materials Research Society Meeting in the Copley Plaza Hotel, Boston, Mass., November 16-21, 1980. The symposia will be conducted concurrently with the common goal of discussing new materials development, new characterization methods or new process technology. Each symposium will provide a forum for exchange of ideas at the forefront of research by experts in the field and topics will be treated at a sophisticated level, in an interdisciplinary way, so all possible physical, chemical and engineering insights can be considered.

The symposia for this year's meeting have been conceptually structured in four major areas: electronic materials, energy materials. materials analysis, new and special materials.

Unless specified otherwise in any of the information regarding individual symposia, the deadline for abstracts to be in the hands of the symposium chairperson is July 1 in the format detailed in the program booklet. A program booklet is available by writing to E. Hawk, MRS Executive Secretary.

For information on specific symposia, contact the respective symposia chairpersons. For general program information contact either of the program chairpersons:

K. N. Tu
IBM Research Center
Yorktown Heights, NY 10598
914/945-1602

C. J. Northrup
Sandia Laboratories
Albuquerque, NM 87175
505/264-5650

For general information concerning the annual meeting contact:

Materials Research Society Secretariat
Ernest M. Hawk, Executive Secretary
102C Materials Research Laboratory
University Park, PA 16802
814/865-3424

VON HIPPEL AWARD OF THE MATERIALS RESEARCH SOCIETY - NOMINATIONS

Nominations are invited for the Von Hippel Award of the Materials Research Society. This prize recognizes outstanding practitioners of the multi-disciplinary endeavor of materials research. It is intended to honor pioneers who have shaped our understanding of the mutual enhancement of the various disciplines engaged in the study of materials. The prize was named after its first recipient, Arthur Von Hippel, emeritus professor at the Massachusetts Institute of Technology. Other recipients include Dr. William O. Baker and Professor David Turnbull. The prize consists of $1000 and a decorative ruby crystal. Nominations with supporting documentation should be sent before September 1, 1980 to the Chairman of the Awards Committee, Dr. Rudolf J. H. Voorhoeve, c/o Celanese Corp., Summit, N. J. 07901.

1981 ANNUAL MEETING DATE SET

The 1981 Annual Meeting will be held in Boston, Massachusetts, at the Copley Plaza Hotel from November 15 to November 20. The Lenox Hotel will serve as additional accommodation for attendees.

Program Chairmen for this meeting will be H. J. Leamy (Bell Labs 201 582-2628), P. A. Montano (West Virginia University (304 293-5769), and C. W. White (Oak Ridge, 615 574-6295).

The Chairmen held a meeting at Oak Ridge National Laboratory on June 10 to discuss the 1981 program. Several new developments were proposed and a tentative list of symposia will be given in the next newsletter. The Chairmen welcome any suggestions for new symposia topics.

MATERIALS RESEARCH SOCIETY
ORGANIZATION, 1980

Officers

President
J. M. Poate, Bell Laboratories

Vice Presidents
K. N. Tu, IBM Thomas J. Watson Research Center
C. J. Northrup, Sandia Laboratories

Secretary
B. C. Giessen, Northeastern University

Treasurer
K. C. Taylor, General Motors Technical Center

Executive Directors
A. Tarpinian, Army Materials and Mechanics Research Center
E. Hawk, Pennsylvania State University

Councillors

E. Baer, Case Western University
T. Barbee, Stanford University
G. E. Brock, IBM
H. S. Chen, Bell Laboratories
F. Gamble, Exxon
H. C. Gatos, MIT
K. A. Jackson, Bell Laboratories
H. J. Leamy, Bell Laboratories
F. Lemkey, United Technologies
J. W. Mayer, Cal. Tech. University
G. J. McCarthy, North Dakota State University
P. A. Montano, West Virginia University
M. Myers, Xerox
H. Poppa, NASA-AMES
R. Roy, Penn. State University
R. J. H. Voorhoeve (Past President), Celanese
J. H. Wernick, Bell Laboratories
W. S. Williams, University of Illinois

MATERIALS RESEARCH SOCIETY
102C Materials Research Laboratory
University Park, PA 16802