Workshop Focuses on Analysis and Interpretation of Neutron Reflectivity Data

A workshop held August 23-25, 1990 at the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory focused on the status of instrumental, theoretical and analytical techniques in neutron reflectivity. The workshop was sponsored by the Department of Energy's Office of Basic Energy Sciences, the University of Chicago, and the Division of Education Programs at Argonne National Laboratory. The workshop brought together 65 scientists from the international polymer science, materials science, condensed matter physics and mathematics communities who are actively performing research using neutron and x-ray reflectivity, and who are pursuing studies on the surface and interfacial behavior of materials. The proceedings of the workshop will be published in a special issue of *Physica B*.

The first day's presentations surveyed the different observables in the grazing incidence geometry. J. Penfold (Rutherford-Appleton Laboratory) began with a discussion of time-of-flight and fixed-wavelength neutron reflectometers. S. Sinha (Brookhaven National Laboratory) followed with a critical comparison and description of the complementary nature of x-ray and neutron reflectivity. His lecture, along with that of A. Steyerl (University of Rhode Island), also dealt with the measurement and interpretation of, and problems associated with off-specular or diffuse scattering. Finally, C.F. Majkrzak (National Institute of Standards and Technology) discussed the experimental methods for producing and detecting polarized neutrons for the study of surface magnetism.

The second day was dedicated to the methods for extracting information (depth profiles) from reflectivity data. J. Lekner (Victoria University of Wellington) began with a lecture on the theory of reflectivity and some limitations on interpreting reflectivity experiments. Complementing this was a lecture by D.S. Sivia (Los Alamos National Laboratory) dealing with the details of maximum entropy and Boyesian spectral analysis for determining the scattering length density profiles from experiment and elucidated several pitfalls encountered in handling data. Contrast variation techniques for suppressing background and highlighting specific components of a specimen were treated by R. Thomas (Oxford University). The unsolved "inverse problem" was then discussed by T. Roberts (Ames Laboratory), who presented some analytic approaches coupled with numerical analysis by which the "inverse problem" could be addressed. At the end of the day, D. Mill (Argonne National Laboratory) presented the potentials of x-ray reflectivity and other surface sensitive techniques at the planned Advanced Photon Source.

On the third morning, some experienced users presented their views on neutron reflectivity. In particular, lectures were presented by J. Higgins (Imperial College) and E.J. Kramer (Cornell University). In the first presentation the possibility of performing straightforward and simple analyses of reflectivity results akin to that in small-angle x-ray or neutron scattering was addressed and the conclusion was that the potential exists but not presently. The final lecture dealt with the importance of using complementary techniques (for example, ion beam scattering, secondary ion mass spectrometry or photoelectron spectroscopy) to assist in studies on interfacial phenomena. At the least such studies set stringent boundaries on the models derived from reflectivity experiments.

This workshop, organized by G.P. Felcher (Argonne National Laboratory) and T.P. Russell (IBM), was designed to maximize discussions among the attendees. Equal time was allowed for the presentations and for the discussion periods, and each was monitored by a discussion leader. Aside from the invited lectures, contributed presentations were made by some of the attendees to provide additional information or to elucidate points made during the invited presentations. The success of this workshop, prompted the suggestion to hold a second but different workshop on reflectivity within a year, which would be geared toward educating the growing user community in this new experimental technique.

Workshop Marks Inauguration of Glass, Liquid and Amorphous Materials Diffractometer

A two-day meeting was held at Argonne on April 16-17, 1990 to celebrate the inauguration of a new diffractometer that recently came into operation at Argonne's Intense Pulsed Neutron Source (IPNS). The Glass, Liquid and Amorphous Materials Diffractometer (GLAD) was built by a team of Argonne staff members headed by David L. Price, with funding from DOE's Division of Materials Sciences to a participating research team headed by Simon Moss, University of Houston.

The first neutron diffractometer optimized to measure the structures of glasses and liquids, GLAD takes advantage of the copious supply of short-wavelength neutrons available at a pulsed spallation source such as IPNS. The use of wavelengths as low as 0.1Å will make it possible to obtain complete diffraction patterns at low scattering angles and avoid the systematic errors due to absorption and inelasticity effects. For more details, see the article on p. 8 of the August 1990 *MRS BULLETIN*.

More than 70 scientists from various international laboratories and universities attended the workshop. In keynote talks on current interest areas related to amorphous materials, experts outlined the important scientific issues and their structural implications. The speakers included Frank Bates, University of Minnesota; John Cahn, NIST, Sow-Hsin Chen, MIT; John Enderby, Argonne Distinguished Fellow/Bristol University; Lynn Gladden, Cambridge University; Masakatsu Misawa, KEK, Tksukuba; Simon Moss, University of Houston; Sidney Nagel, University of Chicago; Sunil Sinha, Exxon/Brookhaven; Roland Winter, University of Marburg; and Adrian Wright, Reading University. The last half-day of the workshop addressed the use of GLAD, the needs of users, prospects for upgrading the instrument, and plans for research.

7th International IBMM Conference Held in Knoxville

450 Scientists from 27 Countries Attend

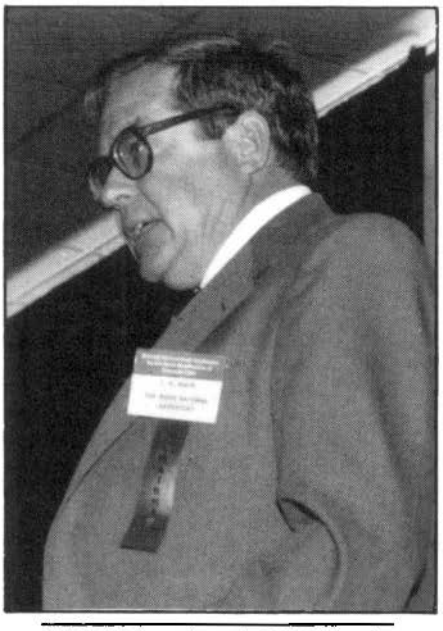
More than 450 scientists from 27 countries attended the Seventh International Conference on Ion Beam Modification of Materials (IBMM 90) held September 9-14 in Knoxville, Tennessee. It was the largest attendance by far for an IBMM conference. This substantial increase over previous conferences in the IBMM series demonstrates the growing importance and activity in ion beam processing. The IBMM series is the most comprehensive conference of those concerned with this field. This year's conference was sponsored by Oak Ridge National Laboratory and cosponsored by the Materials Research Society and the International Union of Pure and Applied Physics.

Approximately 400 papers were presented during eight oral and seven poster sessions. Each half day consisted of a two-hour oral session followed by a two-hour poster session. This format was chosen to provide the maximum opportunity for attendees to interact with their colleagues from around the world.

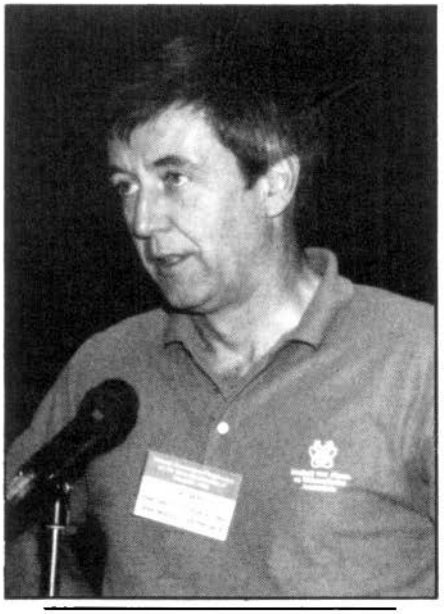
Topical sessions focused on experimental and theoretical work involving beam interactions with a wide range of materials, including semiconductors, metals, ceramics, insulators, and polymers. Other sessions focused on ion-enhanced deposition, tribology, beam-induced crystallization and amorphization, and recent developments in equipment design and experimental techniques. An evening session entitled "New Directions for Ion Beam Processing and Analysis" featured presentations on advanced ion beam processing projects in Japan, new initiatives for ion beam modification of materials, and the use of ion beams in analysis of art and architecture.

In a wrap-up session on the last day of the conference, Frans Saris of the FOM Institute in Amsterdam, the Netherlands, analyzed the most interesting work presented. Topping his list was the use of ion beams to prepare waveguides and electro-optical materials, which he suggested would be an important future direction for research in materials modification.

Other developments of special interest to the ion beam community included experimental results challenging earlier claims concerning thin film deposition using ion beam clusters, and molecular dynamic calculations that gave a new picture of considerable mixing occurring during the interaction of a cluster with a surface. In another area of ion beam research, the adhesion of overlayer films was found to be enhanced for ion species, implanted at the film substrate interface, which exhibit relatively equal chemical reactivity with both the substrate and overlayer atoms. Interesting work on defect tailoring in Si using multiple implants and multiple anneals was also presented.



C.W. White, co-chair of IBMM 90 with B.R. Appleton, welcomes participants.



F. Saris, FOM Institute, Amsterdam, describes the use of ion beams to prepare waveguides and electro-optical materials.

An equipment show, new to IBMM conferences, was very successful, featuring booths from 27 corporations and research laboratories. The equipment show and technical poster sessions were held concurrently in the same venue, enhancing interaction of the conferees with both events. All posters for the two poster sessions each day were displayed the entire day.

A reception for conference participants was held Sunday evening, and a buffet lunch was served each day. After the Tuesday evening session, a reception was hosted by the Kaiserlich-Königliche Böhmische Physicalische Gesellschaft. On Wednesday afternoon attendees were able to choose from a selection of outings, including hiking or touring in the nearby Great Smoky Mountains National Park, or visiting the world-famous Museum of Appalachia near Oak Ridge.

Following the outing, conferees attended a most unusual conference banquet at the Dixie Stampede, a local tourist attraction in Pigeon Forge, Tennessee. The banquet featured wild west Americana and music. Long after some of the science presented at IBMM 90 has been surpassed or refuted, the banquet show, which featured several conferees, will certainly be remembered. Fourteen persons won't soon forget the hour they were trapped in an elevator while their fellow conferees were enjoying post-outing refreshments. A spouses program included visits to many local attractions.

The IBMM 90 Conference proceedings (edited by Stephen P. Withrow and David B. Poker, Oak Ridge National Laboratory) will be published in *Nuclear Instruments and Methods-B*. The next conference in the IBMM series will be held in the summer of 1992 in Heidelberg, Germany.

Stephen P. Withrow

NIST Workshop Highlights Cold Neutron Research Facility

The National Institute of Standards and Technology (NIST), which operates a 20 MW research reactor as part of its Materials Science and Engineering Laboratory (MSEL), is expanding the reactor's experimental facilities. A Cold Neutron Research Facility (CNRF) to fully exploit the 16 liter D_2O cold source installed in 1987 is scheduled for its first operation in late 1990. The 1800 m^2 experimental hall of the CNRF will eventually house at least 15 new experimental stations on seven neutron guide tubes, with capabilities beyond any currently available in the United States.

In order to inform and involve a broad-based community of researchers in many fields of science and technology during detailed planning for the CNRF, NIST held a series of workshops, each focusing on a major area of cold neutron research and applications. The third workshop held May 22-23, 1989, focused on analytical measurements with cold neutrons, using prompt gamma neutron activation analysis (PGAA) and neutron depth profiling (NDP). These nondestructive quantitative techniques, now in use at NIST with thermal neutron beams, will take advantage of the special properties of cold neutrons to address applications in chemical analysis, materials science, and physics research.

The workshop was organized by R. Lindstrom (NIST) and R.G. Downing (NIST), and attended by 46 scientists and business representatives from academic, industrial, and government laboratories. Invited speakers reviewed current work with instrumental neutron techniques in a variety of disciplines including semiconductors, polymers, metallurgy, superconductors, biology, environmental monitoring, and fundamental physics. Additional presentations covered projected improvements with the CNRF instruments in detection limits, throughput, spatial resolution, and additional capabilities in applied and research applications. Participants discussed present and future measurement needs in order to better design the PGAA and NDP instruments to serve both research and applied users. User policies for the facility were presented.

An important part of the workshop was the active participation of the attendees in assessing the capabilities of and the need for various types of instrumentation. The workshop afforded potential users a unique opportunity to guide the development of the CNRF through discussions. After the presentations, participants toured the CNRF reactor and the guide hall.

The cold-neutron NDP instrument has been installed, and the first measurements are now being made. In addition to higher neutron flux than in the current instrument, the new apparatus offers multiple detectors, the ability to manipulate 100-mm samples in three axes, and controlled atmosphere for *in-situ* modification of surfaces. The first measurements will be made with the PGAA instrument before the end of 1990. Because of the extreme purity of the beam, this system will feature greatly improved background, especially for hydrogen; experience with similar cold neutron beams elsewhere suggests that a few micrograms of hydrogen should be measurable in a wide variety of sample matrices.

Neutron Diffraction Workshop Considers Residual Stress

On May 22-23, 1990, a workshop on the Application of Neutron Diffraction to the Determination of Residual Stress in Engineering Materials was held at Argonne National Laboratory, Argonne, Illinois. The workshop was sponsored by the Materials and Components Technology and the Intense Pulsed Neutron Source Divisions with partial support from the Division of Educational Programs.

Organized by David Kupperman (Argonne) and Aaron D. Krawitz (University of Missouri), the workshop provided a mix of tutorials, a panel discussion, a demonstration experiment and also time for information exchange among the attendees. More than 30 scientists and engineers from England, Canada, France, and Denmark attended, representing industry, academia, and government institutions and giving the workshop an international flavor.

Talks were given by recognized experts in the field with ample time provided for attendees and speakers to address issues and concerns regarding the use of neutron diffraction. Examples covered a wide range of materials and geometries from pipe welds to advanced composites, with applications in a wide variety of industries.

The success of the workshop was largely due to the enthusiasm and quality of the participants. As a result, the possibility of a second workshop in 1992 is being discussed. □