

Highlights of IBMM '86

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The 5th International Conference on Ion Beam Modification of Materials (IBMM '86) was held near Catania, Italy, June 9-13, 1986. Conference chairman Emanuele Rimini and his colleagues S. U. Campisano and G. Foti from the University of Catania along with session organizers J. Biersack, J. W. Coburn, C. Cohen, J. A. Davies, G. Dearnaley, O. Meyer, M. A. Nicolet, S. T. Picraux, J. M. Poate, H. Ryssel, F. W. Saris, P. Thevenard, J. S. Williams, and G. K. Wolf put together a stimulating, comprehensive program. A complement of 47 talks and 292 posters spanned beam energies from 1.7 GeV ("First Results at GANIL," Balanzat et al.) to 20 eV ("Ion Beam Deposition of Isotopic Thin Films," Appleton, Herbots and co-workers) and spanned topics from the most fundamental ("Energy Transfer in Solid Air During Ion Bombardment," W. L. Brown) to the most technological ("Trends in Ion Implantation in Silicon VLSI Technology," Tokuyama).

Three hundred participants from 30 countries including the USSR gathered to talk science, drink wine, and enjoy the Sicilian sun. The meeting site, in the small town of Acireale just north of Catania, was a conference center and hotel, La Perla Ionica. It sits on the rocky shoreline where local fishermen can be seen casting and retrieving their nets. This resort's many attractions could be sampled during a long mid-afternoon break in the technical program.



IBMM '86 Conference Chairman, Emanuele Rimini (left) of the University of Catania presides over question-and-answer exchange following Mayer's keynote speech.

The welcoming address was given by the Rector of the Catania University, Gaspare Rodolico. He mentioned the development of physics in Catania and the relevance of these exchanges for the progress of science. He concluded his address by presenting, on behalf of Catania University, a silver medal to Jim Mayer with the following statement: "To Professor James W. Mayer for the long, fruitful and illuminating collaboration

with the physicists of the Catania Aetheneum." The collaboration started 15 years ago between Mayer and Rimini and has been continued with Foti and Campisano.

Mayer then took the podium and got the conference off to a lively start with a review of his group's work on metastable phase formation by ion beam mixing. He described how Ne and Xe beams are used to mix samples consisting of inter-wedge-shaped metal films to give a continuum of possible compositions and concluded, among other things, that equilibrium phases with two atoms per unit cell were the most likely to form. Several additional talks and a poster session were devoted to trying to understand the mixing process: why metals mix or fail to mix and why some phases are amorphous after mixing. Formation of metastable icosahedral phases of AlMn by ion beam mixing was also reported. Since icosahedral unit cells cannot be used to fill three-dimensional space, the exact structure and the properties of these "quasicrystals" have generated much interest. Another popular topic in this session was the use of ion beam mixing of metal overlayers on Si to form silicides at temperatures lower than the thermal reaction temperature.

In his presentation, Mayer raised the question, "how amorphous is amorphous?" Several aspects of this problem were addressed throughout the conference. The current understanding of the delicate balance between beam-induced crystallization and amorphization of silicon was reviewed.



Rector of the University of Catania, Gaspare Rodolico (facing) presents silver medal to James W. Mayer of Cornell University.

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MRS Councillor and former Von Hippel Award recipient, Walter L. Brown (left) of AT&T Bell Laboratories presents commemorative plaque signed by participants to Conference Chairman Rimini during the conference banquet.

It turns out that by changing the temperature and dose rate of the irradiation, the motion of the amorphous-to-crystalline interface can actually be reversed! Studies of diffusion of Cu, Ag, and Au in amorphous Si showed a concentration dependence. The magnitudes of the diffusion coefficients, when extrapolated to high temperatures, correlate remarkably well with those in crystalline silicon, implying that these species diffuse via a substitutional-like process.

Much effort in the ion beam community is devoted to removing the damage created by the implantation process. Recent results on high-temperature annealing of buried oxygen implants showed the creation of a buried SiO<sub>2</sub> layer from sub-stoichiometric doses and drastic reduction of the defects in the overlayer. The layer formation seems to proceed via growth and nucleation of SiO<sub>2</sub> precipitates which appear during the implant. Successful use of rapid thermal annealing (RTA) for damage removal and for activation of dopants and contacts in GaAs was reported by various groups, apparently making it the technique of choice (over conventional furnaces) for GaAs.

The talks and posters on beam-induced changes in multilayer structures (e.g., Si/Ge and AlAs/GaAs) generated a great deal of excitement. Although still very much a mystery, the novel mixing and diffusion effects that have been observed have potential applications for localized bandgap engineering on a single wafer. Furthermore, the observation of transient enhanced diffusion in Si following high-

temperature annealing of high-dose implants may provide clues to what is happening in the multilayers.

The use of ion beams in growth and etching of thin films was discussed by several groups. An innovative technique for depositing thin isotopic films by decelerating a high voltage ion beam is starting to yield information on fundamental particle-solid interactions. Using the sensitivity of ion scattering to different isotopes, the film-to-substrate interface can be studied during subsequent ion beam mixing or annealing. Furthermore, the application of ion beams during or after thin film growth can modify the film adhesion, strain, density, chemical composition, electrical resistivity, index of refraction, and microstructure. The ability to induce these changes in a very controllable way makes ion beam modification not only an extremely useful technique for tailoring materials to specific applications but also an ideal research technique.

The debate about using ion beams in VLSI technology continues with both camps (focused ion beams [FIBs] vs. masked ion beam lithography) making considerable progress. The Japanese are aggressively pursuing the FIB technology, and they reported 0.01-0.1 μm beam diameters with currents of 100-300 pA and energies from 100-200 keV. Their dose rate is high, 1X10<sup>-3</sup> A/cm<sup>2</sup>, but they observe that the critical dose for amorphization is actually below that of conventional ion beams. Another speaker described a sophisticated system for ion projection lithography. The system

offers blanket exposure with a step-and-repeat option and therefore a considerable speed advantage over FIBs. It may be that the two technologies will find different niches: FIBs in custom IC repairs, and ion beam lithography for large area implants.

The conference was a nice size: large enough to bring us up to date on a reasonable cross section of topics, but small enough to allow us to meet and exchange ideas with many of our distant colleagues. The ongoing development work on new machines (such as high current oxygen implanters and 2 MeV ion implanters) and new fabrication techniques (such as incorporation of ion beams in MBE growth) promise a very exciting technical program at the next IBMM meeting.

The IBMM international committee announced that IBMM '88 will be chaired by S. Namba and held in Japan. MRS cosponsorship of the IBMM series will continue and additional MRS cosponsored events are being planned to coincide with the 1988 venue in Japan.

## Boehmische Physical Society Meets at IBMM '86

Since its inception, the Boehmische Physical Society, the members of which all have interests in particle-solid interactions, has taken advantage of the occurrence of conferences in related fields to hold its gatherings. In this way, "a significant fraction of Boehmische members are able to attend without additional travel expense," according to B. Manfred Ullrich, secretary of the society. Meetings are usually held in the evening and consist of a keynote address by a prominent scientist followed by, or sometimes coincident with, the sampling of various regional wines and cheeses. Talks

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S. Tom Picraux (Sandia National Laboratories) (left), 1987 MRS Fall Meeting Co-chairman, receives a Boehmische award from Jim Mayer.