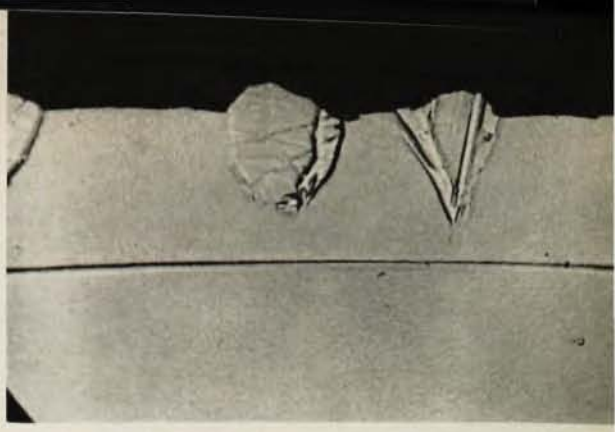
MEETINGS



Photomicrograph of cross section of epitaxially grown germanium layer (Ruth). Etched junction line separates original seed crystal (below) and single-crystal vapor-deposited layer (above). Uniformity of grown layer is greatest near junction.

Physics Symposium in Michigan

NOBEL laureates Peter Debye, John Bardeen, and William Shockley, together with Rudolf Mössbauer, Ralph Sawyer, Sam Goudsmit, and Jack Morton, were among thirty physicists who participated in a symposium held in October at the Bendix Corporation's Research Laboratories Division in Southfield, Michigan.

In the opening address Professor Debye reminisced on his associations with Arnold Sommerfeld and other physicists of that time. He related how Sommerfeld had shown that an electron traveling at speeds greater than the speed of light would create an electromagnetic "shock wave" comparable to the mechanical shock wave produced by an object traveling at speeds greater than the speed of sound. Shortly thereafter, Einstein, in his theory of relativity, showed that the velocity of light in vacuum could not be exceeded and Sommerfeld's theory was forgotten. It was so completely forgotten that when Frank and Tamm used a similar argument to explain the radiation discovered by Cerenkov, they were awarded, jointly with Cerenkov, the Nobel prize.

At a session chaired by Ralph Sawyer, vice president of the University of Michigan and chairman of the Governing Board of AIP, Bardeen was the opening speaker. He discussed various experiments in superconductivity, the results of which are accurately accounted for by the now well-known Bardeen-Cooper-Schreiffer theory. He pointed out that there were other areas in physics where the BCS approach appeared to be of interest. Thus many of the concepts in the field of superconductivity apply also to a superfluid, and the liquid-drop model theory of the nucleus appears amenable to the BCS approach. A superconductor and a superfluid drop both require a small energy increment to destroy their "super" condition. In the superfluid nucleus, the required energy gap is attributable to the pairing of electron spins on the Fermi surface.

Mössbauer followed with a report of recent uses of the effect which bears his name. Interestingly, he did not include a discussion of the relativity experiments at Harvard and Harwell (which employed the Mössbauer effect to prove conclusively for the first time the existence of Einstein's predicted gravitational red shift). Rather he concentrated on a discussion of the use of the exceptionally precise frequency of recoil-free gamma rays in determining properties of matter. He explained how the internal magnetic field of ferromagnetic Fe^{57} causes, by the Zeeman effect, the emitted gamma-ray line to be split into six well-separated lines. If the internal magnetic field is removed (by binding Fe^{57} into a stainless steel lattice) the six lines collapse into one; the "unsplit" emitter line can then be "scanned" over the line spectra of other related absorbers.

Shockley discussed some results on secondary ionization in *p-n* junctions which he had presented earlier at

Peter Debye, John Bardeen, Winston Kock, William Shockley, Ralph Sawyer. (*Ann Arbor News photo*)

the Prague Semiconductor Conference. Since this type of ionization can be compared with secondary emission and multiplication in that the energy of the ionizing carrier must be large enough to enable the new carrier pairs to create more pairs, previous approaches assumed that, as in a Townsend discharge, this energy must be twice the known 1.1 ev energy gap (for silicon). Shockley proposed instead a statistical mechanism involving the acoustical lattice modes (the Raman frequency for silicon corresponding to 0.06 ev) and an assumed mean free path of the ionizing carrier of 50 angstrom units.

A session on epitaxial growth in semiconductors followed, and Bell Laboratories Vice President Morton, who chaired the session, referred to the process as one equal in importance to the diffusion process. Ian Ross, director of semiconductor development at Bell Laboratories, described one form of epitaxial transistor which operates at exceptionally high frequencies through a reduction in the adverse effect of stored carriers. In this unit the number of such carriers is reduced and the lower collector resistance shortens the time needed for removal of these carriers. Ross' photos of layers grown epitaxially on seed crystals showed remarkable smoothness. Ralph Ruth of the Bendix Laboratories showed many photographs of single-crystal vapor-deposited layers of germanium. He discussed the dependence of growth rate of the deposition layer on the orientation of the seed crystal and pointed out that growth was more rapid when the (110) orientation was used. One photograph of a cross section of a crystal and its grown layer showed the extreme uniformity of both the seed crystal and the grown layer in the vicinity of the junction. Dr. Ross had earlier indicated that with interference methods he had been able to ascertain that his grown layers were as smooth as the original seed surface. When questioned regarding the requirements for a lattice match between substrate and deposited material, Dr. Ruth described a vapor-deposited layer of germanium which he had grown on a seed crystal of gallium arsenide. Dr. Ross also expressed the opinion that a close lattice match would not prove to be essential to the epitaxial process.

At a session chaired by David Dennison, chairman of the Physics Department of the University of Michigan, D. C. Cronemeyer of the Bendix Laboratories presented a discussion of the problem of the deep states in semiconductors. He observed that the only theory available today predicts energies of a few hundredths of an electron volt for hydrogen-like impurities in semiconductors. These shallow states are in general observed experimentally; on the other hand there are many impurities which engender deep states (high ionization energies) in germanium and silicon. Since these states can act as recombination centers, improved infrared detectors have resulted through the addition of unusual dopants (such as gold and zinc) to germanium. Cronemeyer mentioned that the aid of W. Thirring of the University of Vienna has been enlisted for a theoretical attack on the problem of the deep states. He emphasized the need for more experimental data on the effects

Rudolph Mössbauer and N. R. Nelson.

caused by the introduction of various impurities not yet tried. Chihiro Kikuchi of the University of Michigan discussed certain aspects of stimulated emission devices, concentrating on a consideration of the transitions available and those required for the most efficient operation of a maser. W. C. Wiley of Bendix concluded the session with a discussion of recent developments in electron multiplication techniques. Participants in a final round-table discussion included Goudsmit (Brookhaven), Martin Stearns (Wayne U.), Henry Gomberg and Joseph Boyd (U. of Michigan), Urner Liddell (ARPA), Col. E. C. Mallary (WADD), and Capt. N. R. Nelson (BuShips).

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Electron Beams

THE third annual Symposium on Electron Beam Technology, organized under the auspices of Alloyd Electronics Corporation, will be held March 23–24 in Boston. The program will cover the following topics: (1) electron beam physics; (2) welding and refining; (3) applications of electron beams for advanced techniques such as polymerization, food processing, etc.; and (4) the present and future applications of electron beams to microelectronics. For detailed information, contact the symposium chairman, R. Bakish, 37 Cambridge Parkway, Cambridge 42, Mass.

Scientific and Engineering Education

DURING the observance of its 100th anniversary, Massachusetts Institute of Technology will hold an International Conference on Problems of Scientific and Engineering Education (April 3–6), in which 100 prominent scholars in the arts and sciences from all over the world will participate. On April 7, a plenary session will follow with internationally known speakers and a summary of the previous three days' discussions. Public panel discussions on "The Future in Arts and Sciences" and "Some Problems of Contemporary Society Posed by Science and Technology" will take place on Saturday, April 8.

Inter-Society Color Council

THE 30th Annual Meeting of the Inter-Society Color Council will be held April 10–12 at the Sheraton Hotel, Rochester, N. Y. The program will include meetings of the color problems subcommittees,