MEETINGS

Chemical Physics of Nonmetallic Crystals

A Conference on the Chemical Physics of Nonmetallic Crystals was held August 28–31, 1961, at Northwestern University. Planned to some extent as a successor to the 1953 Conference on Impurity Phenomena (*Journal of Physical Chemistry*, 1953), the meeting at Northwestern was sponsored by the Divisions of Chemical Physics and of Solid-State Physics of the American Physical Society and by the Division of Physical Chemistry of the American Chemical Society. It was supported by grants from the Atomic Energy Commission, the National Science Foundation, and the Air Force. D. Turnbull (General Electric) was chairman of the planning committee, W. J. Moore (Indiana) headed the program committee, M. E. Fine (Northwestern) was in charge of local arrangements, and O. C. Simpson (Argonne) was conference secretary. The early plans were stimulated by E. Burstein (Pennsylvania).

The principal objectives of the conference were to survey the theoretical bases for understanding perfect nonmetallic crystals, to review the various experimental and theoretical techniques for investigating impurities and imperfections in these crystals, to clarify the chemical and physical aspects of binding and of defects, and to stimulate interaction between experimentalists and theorists and between chemists and physicists investigating these materials. The subject matter of the program was divided into the following categories: quantum theory of nonmetallic crystals, characterization of point defects in crystals, equilibrium properties of dilute solid solutions, and kinetic processes involving point defects.

The conference was open to all desiring to attend and, although not widely publicized, almost 400 chemists and physicists—mainly solid-state scientists—participated. Approximately fifty were from abroad. During the four-day conference, forty-eight papers were presented in nine sessions. There were no simultaneous sessions, so all conferees had the opportunity to hear all papers. With considerable difficulty, but with reasonable success, the session chairmen kept the program close to the schedule; thus, in accordance with the planning, there was adequate time between formal talks for discussion and questions from the floor. In this brief report we shall not attempt to review all the papers but only to comment on representative papers. The manuscripts of all except three of the talks have been published as a supplement to the *Journal of Applied Physics* **33**, 251–518 (1962). Some of the discussion is reported there.

The conference began with two sessions on the quantum theory of nonmetallic crystals. Rather than having a different speaker champion each theoretical approach to the electronic properties of crystals, the program committee chose to have band theory, valence bond, and tight-binding calculations reviewed in a single hour-long opening lecture by P. O. Löwdin (Uppsala). Professor Löwdin presented a balanced review of the different approaches to the theory of nonmetallic crystals. He emphasized the unrestricted Hartree-Fock use of different orbitals for different spins to minimize correlation errors. Vigorous discussions by J. C. Phillips and others followed the opening paper. After several reports of new theoretical work on bonding investigated by nuclear quadrupole coupling and on ionic character, authoritative reviews were presented on crystal field theory by S. Sugano (Bell Laboratories and Tokyo) and on excitons by Laura Roth (Lincoln Laboratory, MIT). Following the talks on the theory of the electronic properties of perfect crystals, Krumhansl (Cornell), in the final paper of the first day, presented a review of lattice dynamics, including localized impurity modes.

The second day had three sessions, including an evening session, on the characterization of point defects in crystals. The first session was devoted to paramagnetic resonance studies of point defects. Pryce (Bristol) considered the electronic structure of point defects quite generally, whereas others considered specific systems in detail. Geschwind (Bell Laboratories) reported on the observation from paramagnetic resonance of the Jahn-Teller effect for Pt^{+}, Cu^{+2}, and Ni^{+3} in Al_2O_3. In addition to resonance studies on point defects, resonance studies on ion pairs were reported by Owen (Oxford) and on paramagnetic impurities at dislocations, by Kawamura (Tokyo). The afternoon session was opened by Gourary (Westinghouse) with a review of the theory of s and p electrons in deep traps. Other theoretical papers were presented by McCombie (Aberdeen, U.K.) on the modification of lattice vibrations by imperfections, by Toyozawa (Tokyo) on self-trapping, and by Kurosawa (Chuo, Tokyo) on vacancy pairs and dislocations.

The Tuesday evening session was concerned with the optical properties of crystals, particularly those determined by point defects. This was one of the most timely and well-coordinated sessions of the conference. Weakliem (RCA) presented and analyzed theoretically polarized optical spectra of transition metal impurities in crystals with the wurtzite structure and in Al_2O_3. The gross spectra are explained by crystal field theory; however, the finer details required invoking the Jahn-Teller effect. During the discussion McIrvine (Ford) indicated that the electron nuclear double-resonance

spectrum of ruby provided more direct evidence of a small displacement of transition-metal ions from the normal Al ion site. Schawlow (Bell Laboratories) reported on the fine-line spectra of Cr^{+3} in MgO and in Al_2O_3 and showed how these spectra can provide information on the fields in crystals. E. W. J. Mitchell (Reading) discussed polarization of luminescence, particularly of diamond; and Morgan (Oak Ridge) presented some striking infrared spectra of polyatomic ions dissolved in alkali halides.

The third day of the conference was devoted to the equilibrium properties of dilute solid solutions. An important trilogy of papers on the interrelations of the concentrations of imperfections was presented by Lidiard (Reading), Brebrick (Lincoln, MIT) and Prener (GE). Lidiard considered point defects in alkali halides; the others, compound semiconductors. In addition, Prener included the effects of association of charged imperfections into ion pairs. Smakula (MIT) described very careful, new work on the hardness and absorption edge of mixed crystals of KCl and KBr. Finally, the Wednesday sessions were terminated by a comprehensive and lucid presentation on defect equilibration mechanisms, particularly those involving dislocations, by J. W. Mitchell (Virginia). This paper laid the groundwork for some of the material of the final day of the conference.

The last day was devoted to kinetic processes, especially diffusion. Lawson (California, Riverside) reviewed the extensive investigations on transport processes in AgBr and made dramatically evident the many unsolved problems relating to the electrical, thermal, and mechanical properties of this material. From the effect of annealing on conductivity, Slifkin (North Carolina) deduced a binding energy for vacancy pairs in AgCl. Friauf (Kansas) discussed correlation effects involved in diffusion in silver and alkali halides and proposed that vacancy pairs may contribute to diffusion in CsBr, CsI, and TlI. Other papers on alkali halides were devoted to the effects of dislocations on conductivity and to the quantitative description of the formation and motion of vacancies. Finally, several papers were presented on proton conduction and dielectric and mechanical relaxation in ice crystals. For example, Eigen (Göttingen) compared the proton conduction of ice to the electron conduction of semiconductors.

In addition to the nine technical sessions, a banquet was held Wednesday evening at which Professor Löwdin gave his humorous version of "How to Prepare a Scientific Paper" and Dr. Klopsteg (Northwestern) outlined the scientific research programs of the host university.

In general, the objectives of the conference were achieved. The background material was authoritatively reviewed, new experimental results and theoretical ideas were presented, the chemists and physicists were to a good approximation indistinguishable, and the experimentalists were usually in attendance when the theorists presented papers. On the other hand, it sometimes seemed that the theorists mainly talked to each other in the halls while the experimentalists presented papers.

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Field Emission Symposium

The Ninth Annual Field Emission Symposium, sponsored by the Department of Physics at the University of Notre Dame and by the Office of Naval Research, was held June 13–15 on the Notre Dame campus. E. A. Coomes served as local chairman, and ONR was represented by A. Shostak, head of the Laboratory's Electronics Branch. There were approximately eighty registrants. The program offered a total of twenty-nine papers on field-ion microscopy and field-electron microscopy, with application to surface physics and chemistry and the properties of metal whiskers. A topic of particular interest was the physics of cesium on tungsten, with regard to adsorption, migration, and desorption. The Linfield research group had its usual fine representation, both in papers presented and in the number of participants.

Among the key papers given were those on the subjects of field-ion microscopy of alloys (by E. W. Müller of Pennsylvania State), field desorption of Ba and Cs from tungsten (by R. Gomer of Chicago), an experimental study of field ionization (by M. J. Southon of Cambridge University), ion-microscopic observations of adatoms (by Gert Ehrlich of General Electric), and field-electron and field-ion emission from single vapor-grown whiskers (by A. J. Melmed of du Pont).

The tenth such symposium will probably be held in early September, 1963. T. H. George of the Union Carbide Corporation will serve as general chairman.

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High Polymers

Canada's National Research Council, in cooperation with the Chemical Institute of Canada, will sponsor the eleventh Canadian High-Polymer Forum at Essex College, Assumption University, Windsor, Ont., on September 5, 6, and 7. This year's forum lecturer will be A. Keller of the University of Bristol, England. The program chairman for the meeting, which will be devoted to all aspects of polymer science, is Dr. D. A. I. Goring, Pulp & Paper Research Institute of Canada, McGill University, Montreal, Que.

Magnetoplasmadynamics

A symposium on the magnetoplasmadynamic generation of electrical power is to be held in England September 6–8, at King's College, University of Durham, Newcastle upon Tyne. The meeting will be sponsored by the northeastern branch of the British Insti-