transport in oxide materials. The activation energies obtained from diffusion measurements are much lower than those calculated theoretically for the formation of a Schottky pair, which strongly suggests that the measurements are being made in the extrinsic range. Purer materials should make possible measurements in the intrinsic range. A new approach to anion mobility based on the kinetics of colour centre aggregation has been used by Luty on alkali halides and it is possible that it may also be used on oxide crystals. The following two papers showed how the gaseous isotope exchange technique to measure anion diffusion could be improved by the use of irradiation. The diffusion of oxygen in CoO was measured by diffusing ^{18}O into a single crystal of CoO and then converting the ^{18}O to ^{18}F by proton irradiation. The distribution of the radioactive ^{18}F in the crystal can then be determined by autoradiographs. It was argued that the larger diffusion coefficients obtained with the normal exchange technique were unreliable because they were determined from shallow penetrations which were susceptible to surface cracks. The basis of the other ion exchange technique was the irradiation of potassium bromide crystals to produce radioactive bromine, prior to the exchange process. Comparison of the results using this method with those obtained by the sectioning technique showed that the latter is much more sensitive in revealing the effect of dislocation diffusion.

Ionic conductivity turned out still to be the principal way of determining the energy of formation of Schottky and Frenkel pairs and the energy for mobility. Measurements on lithium fluoride doped with magnesium fluoride constituted the subject of two papers, each of which modified the previously accepted values for the formation energy of a Schottky defect, for cation vacancy mobility and for the energy of formation of an associated pair. Good correlations were found between the ionic conductivity measurements and diffusion measurements using nuclear magnetic resonance. Conductivity measurements at low temperatures showed the precipitation of magnesium fluoride, or a metastable phase according to the composition and heat treatment. A surprising increase in conductivity was seen in the intrinsic region for deformed crystals of sodium chloride, where dislocation effects may partially account for curvature found in this region. A new method of obtaining the energy of formation of a Schottky defect was proposed by Chang based on the kinetics of solution of precipitates or complexes which is followed by d.c. conductivity measurements. Concern was expressed in the discussion about the effects of polarization on the experimental results.

In the fourth section, on molecular solids, a survey by Dr. J. N. Sherwood of imperfections in molecular solids was the only paper presented. Molecular solids were classified as plastic and non-plastic, apparently in correspondence with spherical and unsymmetrical molecules in a crystal. Self-diffusion studies in these crystals have been made using the techniques of nuclear magnetic resonance, radioactive tracers and creep, which indicate that diffusion is by a vacancy mechanism. Diffusion is much more rapid in the plastic than in the non-plastic materials, and the diffusion coefficients at the melting point are of the order of $10^{-8} \text{ cm}^2 \text{ sec}^{-1}$ and $10^{-11} \text{ cm}^2 \text{ sec}^{-1}$ respectively. Because the bulk diffusivities are so low, diffusion by means of imperfections can be important. The exact mechanisms of diffusion in molecular solids are still far from clear, but diffusion measurements suggest that in the case of plastic crystals, there must be either a high concentration of vacancies or large relaxations around the vacancies.

The final section of the conference was on radiation effects and associated phenomena. The introductory lecture by Dr. R. Kelly and Dr. C. Jech, and the following two papers, described inert gas diffusion in oxides. The principal technique is to bombard a single crystal with an inert gas and then to study its diffusion by following the

outgassing at different temperatures. The diffusion can be controlled by (a) either extrinsic vacancies generated by bombardment or by aliovalent impurities, if an interstitial mechanism is not operative; (b) the break-up of small defect clusters; (c) defects generating dislocations at high gas concentrations and thereby becoming ineffective; (d) the formation of polycrystalline or even amorphous material at high gas concentrations; (e) the intrinsic properties of the crystal at high temperatures. The remaining papers were concerned with the effect of radiation damage on properties other than diffusion. A survey investigation of the changes in electrical, mechanical and optical properties of zirconia which had been exposed to gamma radiation or bombardment with neutrons or neutrons showed that its behaviour is similar to that of the well studied oxides. Silica gel also showed changes of properties when bombarded with neutrons, and in particular the adsorption of nitrogen was considerably reduced. A combination of electron spin resonance optical absorption and lattice parameter measurement has been used to study damage in neutron irradiated magnesium oxide. The initial damage is seen to be associated with the formation of Frenkel defects and F centres. Further irradiation causes the formation of aggregates at the expense of the F centres. An electron microscope study of sodium chloride bombarded with electrons demonstrated some of the grosser effects ranging from small dislocation loops to the point where the strain is relieved by recrystallization.

In conclusion, the strength of this conference, like the first, lay in limiting the scope of material presented so that almost every paper was of interest to those attending. As a field of study, non-metallic crystals now engages solid state physicists, materials scientists, ceramists, chemists and even metallurgists. This conference presented a spectrum of their work to an audience of people with similar diverse interests.

EDWARD LILEY

OBITUARIES

Prof. T. A. Read

PROF. T. A. READ, head of the Department of Mining, Metallurgy and Petroleum Engineering at the University of Illinois, died on September 11 after a short illness. He was only 52, and his tragic early death will be keenly felt by his friends and colleagues in many countries outside the United States.

Tom Read took his A.B. and Ph.D. degrees in physics at Columbia, and then worked successively as Westinghouse Research Fellow, as principal physicist at Frankford Arsenal, and at Oak Ridge National Laboratory, before returning in 1948 to Columbia as associate professor of metallurgy. His scientific interests were diverse and he contributed to many branches of physical metallurgy, but he is perhaps best known for his pioneering work on internal friction in metals, and for the development of the Wechsler-Lieberman-Read theory of the crystallography of martensite transformations. His scientific abilities were accompanied by outstanding talents as an educator and administrator, and his appointment in 1954 to the University of Illinois enabled him to display these to maximum effect. Under his guidance, the metallurgy department flourished and expanded, and close co-operation with the strong physics department was established and maintained. The University of Illinois is now generally recognized as one of the leading centres for both metallurgy and solid state physics, and at the time of his death Tom Read was playing an active part in the organization of the new materials laboratory.

J. W. CHRISTIAN