

enetetramine, a similar molecule with no plastic-crystal phase. A review of entropy data on plastic crystals was also presented, with a discussion of their implications concerning molecular disorder. Other papers included theoretical and Raman-spectral studies of rotation in solid and liquid methane with a correlation of infrared and neutron results. Clarification of spectral assignments in neutron scattering by hydrogenous molecules by selective substitution of atoms with lower cross sections was also discussed.

Polymers. David McCall (Bell Telephone Laboratories) gave a comprehensive survey of the investigation of molecular motion and relaxation in polymers by NMR, dielectric, and dynamic-mechanical methods. He discussed the various theoretical approaches to relaxation phenomena and provided a description of the various relaxation processes (main-chain reorientation, side-group motions, etc.). Correlation frequencies as functions of temperature, derived from the three types of relaxation measurements, were shown to be quite consistent with one another. In addition, molecular mechanisms and activation energies

were assigned for different relaxations. The contributed papers were primarily concerned with the study of vibrational spectra of polymers such as polyethylene and polyoxymethylene by inelastic neutron scattering. Stretched polymers were studied as a function of orientation to aid in the assignment of particular transverse and longitudinal modes, and detailed comparisons were made with infrared results and theoretically calculated vibration spectra to gain insights into the forces that link polymer chains. Of particular interest was an attempt to study dispersion relations by coherent neutron scattering from deuterated polyethylene.

As evidenced by both the lectures and related discussions, the conference succeeded admirably in demonstrating the important advantages of combining results from a number of techniques.

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EDWARD PRINCE

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The Electret: from Freak to Familiarity in Fifty Years

The emergence of the electret as a potentially very useful device whose behavior is quite comprehensible was evident at the symposium on electrets, held in Chicago last October as part of the 132nd meeting of the Electrochemical Society. Electrets, discovered nearly 50 years ago by Mototarô Eguchi, are solid dielectrics that have acquired a real surface charge (homocharge) and also manifest a charge of opposite sign (heterocharge) because of a volume effect. Fascinating phenomena of spontaneous net surface-charge reversal and growth followed by eventual decay result from different decay rates of homocharge and heterocharge. Decay times are typically months or years.

The symposium opened with theoretical papers that showed that the electret can be understood on the basis of very general principles applicable to a wide class of solid dielectrics. Martin Perlman and Donald Tilley

(Collège militaire royal, Saint Jean, Québec) reviewed and developed isothermal phenomenological theories. Bernhard Gross (Comissão Nacional de Energia Nuclear) presented the first of a series of major contributions to the meeting made by physicists from Brazil. His powerful general theory treats nonisothermal transients in solid dielectrics with the assumption of linearity and a new principle of "charge reversibility." Succeeding papers given by Sergio Mascarenhas and others (Universidade de São Paulo) showed that "ionic thermal current" measurements are a key to the understanding of the microscopic mechanisms responsible for electret heterocharge and to the study of fundamental solid-state phenomena. This work illuminates the vexed question of the importance of space-charge contributions to electret heterocharge; volume polarization in potassium chloride is due to impurity-vacancy dipoles rather than to

space charge, but in ice electrets space-charge effects dominate. Space charge is also significant in naphthalene.

New techniques and applications. Reports from industrial laboratories in the United States and Canada described new techniques and results for surface-charge measurement and interfacial phenomena. Clifford Lilly and others (Philip Morris Research Center) measured thin-film conduction and showed that a Schottky treatment is compatible with the results.¹

Substantial progress was reported in two quite different applications. The electret microphone, pioneered and developed by Gerhard Sessler and James West at the Bell Telephone Laboratories² has been advanced to the stage of field tests in telephones after the discovery by Perlman and Cornelis Reedyk (Northern Electric Research and Development Laboratories) of film electrets with charge lifetimes estimated to be hundreds of years. Preston Murphy and Frank Holly of the Thermo Electron Engineering Corp., who are interested in the eventual construction of an artificial heart, described a series of experiments on the effect of electrified polymers on the clotting of blood and demonstrated that negative electrets placed in the cardiovascular system of dogs remain reasonably free of thrombus while positive electrets thrombosed severely.

As the participants in this symposium dispersed, they left with the conviction that further investigation of the electret effect will add to our knowledge of fundamental physical processes and lead to many practical applications.

References

1. A. C. Lilly Jr, J. R. McDowell, J. Appl. Phys. **39**, 141 (1968).
2. G. M. Sessler, J. E. West, J. Acoust. Soc. **40**, 1433 (1966).

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The proceedings of the symposium are available from the national headquarters of the Electrochemical Society, 30 E. 42nd St., New York, for \$11.00. Selected papers will be published in the Journal of the Electrochemical Society and in Electrochemical Technology.

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