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This Week's Citation Classic

Lidiard A B. Ionic conductivity. *Handbuch der Physik* **20**:246-349, 1957. [Atomic Energy Research Establishment, Harwell, Berkshire, England]

This article surveys the subject of ionic or electrolytic conductivity in solids. The emphasis is on the explanation of the phenomenon in terms of the occurrence and properties of point defects (vacant lattice sites, interstitial ions, and solute or impurity ions). In this way it shows the relation of conduction properties to other aspects of ionic transport, e.g., electrode effects, dielectric relaxation, diffusion, and thermoelectric power. [The *SCI*® indicates that this paper has been cited in over 975 publications since 1957.]

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"This article was written in 1956 while I held a Senior Research Fellowship at the Atomic Energy Research Establishment (AERE) at Harwell; it was published a year later. Its perspective derived from my work and experience over the preceding three or four years.

"This was a period when science was getting back on its feet after the dislocation caused by World War II; and in Europe that process was aided by the US Fulbright and other exchange programmes which enabled European scientists to work in US universities. I was one of the beneficiaries of those programmes and I joined Fred Seitz at the University of Illinois at Urbana in the fall of 1952. I brought with me a background in statistical mechanics (cooperative phenomena, kinetic theory of liquids, electrolyte solutions, colloids, etc.) obtained by working with Freddy Booth and (the late) Charles Coulson at King's College, London. The scientific atmosphere at Urbana was heady and stimulating. For me it opened up a whole new vista associated with those properties of solids dependent upon the presence of imperfections in their otherwise regular lattice structures. Seitz and his colleagues there had already demonstrated[1] the conceptual unity of the subject, particularly by crossing the traditional boundaries between physics, metallurgy, and chemistry. At their suggestion, I took up the study of point defects in ionic crystals. At that time, there was a need to 'work out' the basic models theoretically, so that experimental measurements could give more direct information about the properties of defects at the atomic level. By using my background in statistical mechanics, I made new analyses of ionic conductivity and dielectric relaxation while I was at the University of Illinois, and continued with calculations of solute diffusion, foreign-ion solubilities, and space charges around dislocations during the following year at the University of California at Berkeley. I went on with this work after I joined AERE in 1954, pursuing mainly the kinetic and random-walk theories of diffusion via defects.

"The invitation to write an article on ionic conductivity for the new Flügge edition of *Handbuch der Physik* arrived in 1956. By then I had given two lecture courses on imperfections in crystalline solids, and this sharpened my perspectives and provided a tested framework which could be used for the review. It was written not so much to be comprehensive as to convey a theoretical point of view —that provided by the theory of point defects— and to show how this enabled one to draw detailed inferences about the properties of these defects from a variety of macroscopic measurements. In this it helped the development of the subject of 'defect solid-state physics,' i.e., of a theoretically coherent study based on a few basic structural elements, the imperfections.[1] The article appeared fairly early in this development and the principles and point of view which it advanced stood the test of time well. However, the last dozen years or so have seen a considerable growth of interest in highly disordered ionic solids, the so-called super- or fast-ionic conductors. At the time the article was written, there appeared to be just a few rather special substances of this kind. Nowa-days, therefore, the article looks somewhat incomplete.

"There are many reviews and books dealing with this topic today. For a review running somewhat parallel to the original article, see Corish and Jacobs.[2] For a report of the topic in relation to defect theory generally, see Flynn.[3] For a report on highly disordered solid electrolytes, see Salamon."[4]

1. **Seitz F.** Imperfections in nearly perfect crystals: a synthesis. (Shockley W, Hollomon J H, Maurer R & Seitz F, eds.) *Imperfections in nearly perfect crystals: symposium held at Pocono Manor, October 12-14. 1950.* New York: Wiley. 1952. p. 3-76.
2. **Corish J & Jacobs P W M.** Point defects in ionic crystals. (Roberts M W & Thomas J M, eds.) *Surface and defect properties of solids.* London, England: Chemical Society, 1973. Vol. 2. p. 160-228.
3. **Flynn C P.** *Point defects and diffusion.* Oxford, England: Clarendon Press, 1972. 826 p.
4. **Salamon M B,** ed. *Physics of superionic conductors.* Berlin: Springer-Verlag, 1979. 255 p.