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Book Reviews

Solid Electrolytes
General Principles, Characterization, Materials, Applications.

Edited by Paul Hagenmuller and W. Van Gool, Academic Press, New York, 1978, 549 pp., $ 52, £ 33.80

The separation of the book into three parts:
- Theory and experimental methods (10 papers)
- Materials (13 papers)
- Applications (8 papers)

is justified in the Introduction in view of the inevitable overlap of subject matter.

For a long time, solid-state electrochemistry had difficulty in showing that it was a field in itself, with only a few compounds known, and with relevant papers published in diverse journals; the beneficial effect of theory in this domain is recent. For instance, the truly electrochemical method of complex impedance analysis (Ch. 10) and the theory of diffusion in solids with point defects (Ch. 5) or domains (Ch. 2) can be complemented by the methods of solid-state physics. With a knowledge of the optimum structure (Ch. 3) for conduction, X-ray analysis (Ch. 4) is essential in the study of crystalline electrolytes. Later the characterization of the ceramic microstructure will be needed for practical purposes (Ch. 9).

Nuclear magnetic resonance (Ch. 7) yields information on the mobility of selected ions (H^+, Li^+, Na^+, F^-) which can corroborate the conductivity studies. Electron spin resonance, through the incorporation of paramagnetic ions into the compounds of interest, is used to probe the ionic environment (Ch. 8), and absorption spectra (neutron or infrared) can be directly associated with ion motion and the conductivity of the material (Ch. 6).

Interfacial problems, long neglected, receive a general treatment (Ch. 11) similar to that of semiconductor junctions.

Solid electrolytes comprise mainly conductors of the following ions: H^+, Li^+, Na^+, K^+, Ag^+, Cu^+, F^-, O^{2-}.

Highly conductive α-AgI has been the basis of a wide variety of related compounds with both organic (Ch. 13) and inorganic (Ch. 14) substituents. They have found limited use in low-energy-density batteries (Ch. 26) and as components in ion-selective electrodes (Ch. 31). The same analysis has been successfully applied to copper conductors (Ch. 13 and 15).

The exhaustive survey of the simple mixed oxides and halides (Ch. 20), zeolites (Ch. 24) and other skeleton (Ch. 23) structures, and tunnel or sheet materials (Ch. 22), reflects the enormous effort in the search for compounds with high cationic (especially Li^+ and Na^+) mobilities at low temperatures.

β and β''-aluminas, with their potentially large scale use in the Na/S battery (Ch. 27), deserve the special attention given to their structure and defects (Ch. 16.).

Anionic conductivity (F^-, O^{2-}) in the CaF_2 (ZrO_2) or LaF_3 (Ch. 19, 19) related structures and its enhancement by cation polarizability (PbF_2, Bi_2O_3) is described. ZrO_2-based electrolytes now cover a variety of applications — for thermodynamic measurements (Ch. 28, 29), fuel cells (Ch. 25) or high temperature resistors (Ch. 30).

Beyond the scope of electrolytes alone, the study of mixed conductors (Ch. 21) opens the field of high-energy electrode materials, or electrochromic displays.

This book covers relatively completely, with well documented papers, the field of solid electrolytes. However, in this fast moving field, the delay between the call for papers and publication of the book makes a satisfactory updating difficult. This is especially noticeable for solid electrolytes as dispersed phases and for ill-condensed materials (glasses, Ch. 17) with potential applications almost equal to that of β-alumina (Na/S battery).

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Lead–Acid Batteries
by H. Bode, John Wiley, New York, 1977, 387 pp.

The lead–acid battery is the faithful old retainer of electricity — it has seen honourable service for over one hundred years and has demonstrated its reliability, versatility, and cheapness in a wide variety of automotive, stationary and traction applications. Why then has there been a renaissance in lead–acid battery research during the past decade?

Initially, the renewed interest lay in the application of modern analytical techniques developed in other disciplines to examine further the chemical and physical processes taking place in battery plates. Investigations using techniques such as scanning electron microscopy and electron probe microscopy became commonplace and the scientific press was bombarded with a kaleidoscope of electron micrographs that revealed both positive and negative active materials in a variety of crystal habits during preparation, formation, and utilization of battery plates. Such studies, in turn, gave rise to an avalanche of theories on the mechanism, limitations, and failure modes of the system.

More recently, research on lead–acid batteries has been stimulated through recognition that world energy supplies are very much dependent on petroleum fuels. The situation is becoming particularly serious in the transportation sector, and difficulties in guaranteeing continuous oil supplies,