Book Review

Solid-state Protonic Conductors III For Fuel Cells and Sensors

Edited by John B Goodenough, Johs Jensen and Antoine Potier, Odense University Press, 1985, 284 pp , Price U S $20

This book reports the Proceedings of the Third Workshop on "Solid-state Materials for Low to Medium Temperature Fuel Cells and Monitors, with Special Emphasis on Proton Conductors", held at La Grande Motte, France, in May, 1984

In the preface, we are informed that in the call for papers, "particular emphasis was placed on the need for more information on the following topics: (a) the structural and dynamic properties of protonic electrolytes, their purity and their behavior in contact with an electrolyte; (b) the phenomenological and physical intepretation of complex admittance measurements; (c) device design and materials specifications".

The interest in proton conductors is easy to justify; for theoretical reasons due to the translocation (Grotthus type) mechanism for transport, which is almost unique among ions, for applications also considering the ubiquity of hydrogen in nature. The revived interest in fuel cells, shown recently in the developed countries, reflects this consideration.

Solid proton conductors fall into two main categories: (i) hydrates (or ammoniates), where water is included as in surface particle hydrates, structural hydronium compounds, ion-exchange membranes; (ii) anhydrous hydrogen derivatives whose conductivity is usually observed above room temperature

There were no reports on Nafion type membranes, in contrast to the preceeding volumes.

Materials under study were oxonium salts (one paper), hydrogen uranyl phosphate, HUP (5), tetravalent metal phosphates (2), β-alumina (1), zeolites (2), and molybdic acid (1)

HUP itself has recently been the subject of controversy concerning its true bulk conductivity, as opposed to grain boundaries containing adsorbed phosphoric acid In the light of the contributions presented in this book, it appears that HUP has, effectively, a high intrinsic conductivity but a narrow stability domain, limited both in P and phosphate ion concentration.

MnO_2–HUP compostes (1), however, behave remarkably well, establishing that H_xMnO_2 is a reversible intercalation material with fast kinetics; vanadium pentoxide gels (1) also show electron and proton mobility.

Anhydrous protonic conduction (1) is observed in triethylenediamine salts but it requires a temperature of 100 - 200 °C.

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All these materials are introduced with more general contributions: a survey of impedance spectroscopy applied in general to solid ionic conductors (2), physical methods (3) including neutron diffraction, NMR, surface properties.

It is probably true, as stated in the foreword, that solid-state protonic conductors have generally stayed outside the mainstream of solid electrolytes. This situation probably arises from the fact that most protonic materials require water for conduction and are rarely claimed by either aqueous solution or solid-state electrochemists.

The scientific community involved in proton conductors is small but very active, with three proceedings, published over six years, on a diversity of subjects. This latest volume leaves the impression that scientific effort should now be directed to finding new materials having more reliable characteristics than presently known electrolytes, especially those involving "anhydrous" conduction, since study and application techniques are already well understood.

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