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Department of Materials Engineering
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The Science and Technology of Oxyanion Based Superprotonic Conductors

by

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Several alkali acid sulfates, phosphates and selenates are known to undergo superprotonic transitions in response to a change in temperature (or pressure). Examples include $CsHSO_4$, $Cs_5(HSO_4)_3(H_2PO_4)_2$, and $Rb_3H(SeO_4)_3$, which have tetragonal, cubic and trigonal high temperature phases, respectively, at which the conductivity jumps 3-5 orders of magnitude. In contrast to ferroelectric transitions, which such materials can also undergo, there are no widely accepted guidelines for predicting high-temperature superprotonic behavior based on room temperature structure or properties. A review of the properties of a broad range of oxyanion based superprotonic compounds, many of which have been discovered in our laboratory, provides some clues as to the structural and chemical prerequisites. These include features such as large alkali cations and complex room temperature structures.

In addition to the rich chemistry of oxyanion based solid acids, such materials hold promise as fuel cell electrolytes, and in other electrochemical devices. In fuel applications, solid acids offer several advantages over polymeric membranes, greater thermal stability and anhydrous proton transport. The current status of our efforts to develop viable solid acid fuel cells is reviewed, and the outstanding challenges described.

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