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Tetravalent metal pyrophosphates and their composites: New electrolytes for intermediate-temperature fuel cells

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Acceptor-doped tetravalent metal pyrophosphates (MP_2O_7 ; M=Sn, Zr, Ce, Ti, etc.) have shown significant proton conductivity of $A > 10^{-2} \text{ S cm}^{-1}$ in 100-300°C range and are being considered promising electrolytes in proton-conducting ceramic electrolyte fuel cells (PCFCs). But, poor sintering-ability of the tetravalent metal pyrophosphate (TMP) has posed one of the major challenges in their application in PCFCs. In an attempt to utilize the potential of these materials in PCFCs, a number of ways ranging from enhancing sintering behavior to the fabrication of composites have been proposed. Herein, we systematically address some of these aspects and present an overview of developments, and present a report on synthesis and characterization of novel TMP and alkali carbonate (A_2CO_3 ; A = Li and/or Na) composites. The TMP-carbonate composites are prepared by mixing indium-doped tin pyrophosphate or yttrium-doped zirconium pyrophosphate with Li_2CO_3 or an eutectic mixture of Li_2CO_3 - Na_2CO_3 in different wt.% ratios. The phase composition, microstructure and electrical conductivity of the sintered specimen are analyzed. In addition, the effect of different TMP and A_2CO_3 phases is investigated. A maximum ionic conductivity of $5.5 \times 10^{-2} \text{ S cm}^{-1}$ at 630°C is observed in this study with a $Sn_{0.9}In_{0.1}P_2O_7$ - Li_2CO_3 composite. Based on the literature data, TMP-carbonate composites can be considered to be primarily a proton and oxygen-ion co-ionic conductor and, therefore, have strong potential as electrolytes in fuel cells in 500-700°C range.

Biography

Bhupendra Singh has expertise in synthesis and characterization of materials for energy conversion & storage, study of defect structure and transport properties of solid state ionic conductors, intermediate-temperature fuel cells. Currently, he is a Ramanujan Fellow at Department of Ceramic Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi, India. He has coauthored more than 50 research publications in the form of peer-reviewed research papers, conference proceedings, book chapters and patents.

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