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Semiconductor-ionic materials for low temperature solid oxide fuel cells and electrolyte-layer free fuel cells

In this work, demonstration of new advanced materials for advanced solid oxide fuel cells (ASOFCs) is reported to lower the operating temperature of solid oxide fuel cells (SOFCs). Nanocomposite semiconductor-ionic ceramic materials are prepared by solid state route through ball milling process and investigated as the catalytic electrode for low temperature solid oxide fuel cells (LTSOFCs) as type I device and core material for electrolyte-layer free fuel cell technology as type II device illustrated in Fig. 1. Synthesized perovskite oxides have exhibited great electrical conductivities, especially the $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ prepared by co-precipitation method has shown a maximum conductivity up to 313 S/cm in air at 550°C measured by DC 4 probe technique. Similarly, $Ni_{0.8}Co_{0.15}Al_{0.05}Li$ (NCAL) oxide has shown balance electrical and ionic conductivity which is very useful for fuel cell performance. Additional advantages of BSCF and NCAL with both ionic and electronic conductivities are their cost effectiveness and low working temperature below 600°C. XRD analysis on the powdered form of BSCF sample exhibited the phase structure as perovskite oxide. Microstructure studies of the samples have revealed homogeneous structure and morphology of the nanoparticles using scanning electron microscopy (SEM). The prepared materials including semiconductor-ionic and perovskite materials have shown very good mechanical strength and stability proving their importance in advanced fuel cell technology using spark plasma sintering technique. Power densities for new energy conversion technology using our synthesized materials are measured between 600-1000 $mWcm^{-2}$.

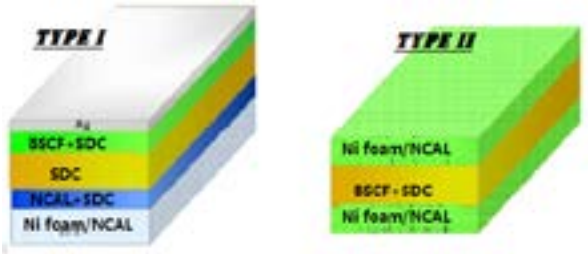

Figure 1: Schematic for SOFC (Type I) and EFFC (Type II).

Biography

Muhammad Afzal obtained his M.Sc in Applied Physics from KTH Royal Institute of Technology, Stockholm, Sweden in 2013 and is continuing PhD in Energy Technology from KTH Royal Institute of Technolo (2012-08-01 to 2015-07-31), STEM and Swedish Resea gy, Stockholm, Sweden since June, 2014. After M.Sc at KTH University, he was appointed as Research Engineer and Project Manager at KTH for EC FP7 TriSOFC rch Council (VR) projects. Today he is an emerging well known scientist in Solid Oxide Fuel Cell and Electrolyte-layer Free Fuel Cell (EFFC) and Manager for Advanced Fuel Cell and Solar Cell Group at KTH. Initially working on conventional SOFC using perovskite and composite materials, his current work focuses on Semiconductor-Ionic materials (Three in One) for the development of EFFC technology working at low temperatures (300-600 °C). He is an international referee for International Journal of Hydrogen Energy, J. Phys Chem B & C, J. Scanning, Electrochimica Acta, Advaced Energy Materials, and Recent Patents on Nanotechnology. He is Guest Editor in International Journal of Scanning. He has published more than 20 papers in refereed international journals.

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