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Structural, electrical and thermal expansion studies of tri-doped ceria electrolyte materials for IT-SOFCs

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ABSTRACT

Nano crystalline tri-doped ceria $Ce_{1-x}(Pr_{1/3}Sm_{1/3}Gd_{1/3})_xO_{2-\delta}$ (x=0.00, 0.06, 0.12, 0.18, 0.24 and 0.30) solid electrolyte materials for intermediate temperature solid oxide fuel cells (IT-SOFCs) were successfully synthesized by sol-gel auto-combustion method. The X-ray diffraction patterns of prepared compositions confirm the sample formation with a single-phase cubic fluorite structure. Reitveld refinement of all the samples carried out by using Fullprof software. The values of lattice parameter and average crystallite size values were calculated from the XRD patterns and were found to vary from 5.4107 Å to 5.4403 Å and from 18 to 32 nm respectively. Relative densities of all the samples were found above 95% after sintering at 1300°C for 4 h. Microstructure and elemental composition were studied using scanning electron microscope (SEM) with energy dispersive spectrum (EDS). Evaluation of the concentration of oxygen vacancies of all the samples was carried out using Raman spectroscopy. The electrical properties of tri-doped ceria system were carried out by A.C. impedance spectroscopy in the temperature range from 250 to 600°C. The investigation on total ionic conductivity was carried out with variation in microstructure and relative oxygen vacancies. It was found that among all the compositions, $Ce_{0.76}Pr_{0.08}Sm_{0.08}Gd_{0.08}O_{2-\delta}$ exhibits highest total ionic conductivity and minimum activation energy. The linear thermal expansion measurements revealed moderate linear thermal expansion coefficient for this composition in