Abstract

In order to meet the growing energy demand, some of the potential non-conventional energy sources are being explored continuously viz., solar, hydrogen, wind, tidal etc. In all these cases, trapping the energy in the efficient and environmentally benign means is very important. For harnessing hydrogen energy, fuel cell is one of the best electrochemical devices which is being studied extensively for its improvement. Among the different types of fuel cells, solid oxide fuel cells (SOFCs) are highly advantageous. This thesis work is focused on exploring the ceria (CeO₂) based electrolytes for improved oxygen ion conductivity meant for intermediate temperature (IT, 873 K – 1073 K)-SOFCs.

Here, different compositions of Ce₁₋ₓGdₓO₂₋δ (x = 0.1–0.3), Ce₁₋ₓSmₓO₂₋δ (x = 0.1–0.3), Ce₀.₈₅Ln₀.₁₅O₂₋δ (Ln = Y³⁺, Gd³⁺, Sm³⁺, Nd³⁺ and La³⁺), Ce₀.₈₅Gd₀.₁₅O₂₋δ and Ce₁₋ₓSrₓO₂₋δ (x = 0.05–0.2) solid solutions were synthesized by wet chemical routes (co-precipitation, citrate-complexation). The structural details were carried out by using TG/DTA, XRD, FT-IR, Raman, FE-SEM with EDX, TEM etc. Then the electrochemical properties were studied by using electrochemical impedance spectroscopy, which gives the oxygen ion conductivity. Among the above solid solutions, Ce₀.₉₀Gd₀.₁₀O₂₋δ (σ₁ = 4.88 × 10⁻⁴ S cm⁻¹), Ce₀.₈₀Gd₀.₂₀O₂₋δ (σ₁ = 4.93 × 10⁻⁴ S cm⁻¹), Ce₀.₈₀Sm₀.₂₀O₂₋δ (σ₁ = 9.73 × 10⁻⁴ S cm⁻¹) and Ce₀.₉₁Sr₀.₀₉O₂₋δ (σ₁ = 1.90 × 10⁻⁴ S cm⁻¹) may be used for SOFCs electrolyte. As these materials exhibits the high oxygen ionic conductivity even at low temperature (473 K – 623 K) compared to the conductivity data available in literature. The ionic migration parameters measurement by Wagner's polarization technique shows that all the synthesized materials are ionic in nature (as t₁₀₀ is close to unity). Simultaneously, we understand and contribute to the basic material chemistry aspects of SOFC in general.