J-009-O

Electrochemical performance of perovskite-related oxide cathodes in contact with lanthanum silicate solid electrolyte

Aleksey Yaremchenko[1], Dmitry Bannikov[2], Vladislav Kharton[1], Jorge Frade[1], Vladimir Cherepanov[2]

[1]Department of Ceramics and Glass Engineering, CICECO, University of Aveiro, Aveiro, Portugal, [2]Chemistry Department, Ural State University, Ekaterinburg, Russian Federation

Solid electrolytes based on apatite-type $La_{10-x}(SiO_4)_6O_{2\pm\delta}$ exhibit a substantially high oxygen-ionic conductivity, moderate thermal expansion, low electronic transport in a wide range of oxygen chemical potential and relatively low cost, and may thus be considered for intermediate-temperature solid oxide fuel cells. The present work was focused on evaluation of electrochemical behavior of selected mixed ionic-electronic conducting cathodes, including perovskite-like $Sr_{0.7}Ce_{0.3}Mn_{0.9}Cr_{0.1}O_{3-\delta}$ and Ruddlesden-Popper $La_4Ni_3O_{10-\delta}$, $La_4Ni_{2.9}Cu_{0.1}O_{10-\delta}$, $La_{3.95}Sr_{0.05}Ni_2CoO_{10-\delta}$ and $LaSr_2Mn_{1.6}Ni_{0.4}O_{7-\delta}$, in contact with $La_{10}Si_5AlO_{26.5}$ electrolyte at 873-1073 K. Porous cathodes with sheet density 12±2 mg/cm^2 were applied onto dense $La_{10}Si_5AlO_{26.5}$ substrates and examined by XRD and SEM/TEM coupled with EDS analyses. The electrode polarization measurements were performed by three-electrode technique in cells with symmetrical working and counter electrodes. For characterization of the electrode materials, dilatometry, thermal analysis, and measurements of electrical conductivity and oxygen permeability were used. The electrochemical activity of nikelate-based cathodes was found to increase in the sequence $La_{3.95}Sr_{0.05}Ni_2CoO_{10-\delta}$ < $La_4Ni_3O_{10-\delta}$ < $La_4Ni_{2.9}Cu_{0.1}O_{10-\delta}$, with the cathodic overpotential values varying in the range 240-370 mV at 1073 K and current density 200 mA/cm^2. The relatively high polarization is primarily associated with the surface diffusion of silica from $La_{10}Si_5AlO_{26.5}$, which partially blocks the electrochemical reaction zone. Compared to layered nickelates, $Sr_{0.7}Ce_{0.3}Mn_{0.9}Cr_{0.1}O_{3-\delta}$ and $LaSr_2Mn_{1.6}Ni_{0.4}O_{7-\delta}$ cathodes showed substantially higher cathodic overpotentials, in correlation with the level of oxygen ionic transport. The poor electrochemical performance in the latter case is also determined by a strong cation interdiffision between the electrode and electrolyte materials which may lead to formation of blocking interlayers.