(Ce,Gd)O$_2$–δ-based dual phase membranes for oxygen separation

Composite membranes based on selected combinations of the ionic conductor Ce$_{0.9}$Gd$_{0.1}$O$_{1.96}$ (CGO) and electronic/mixed conductors (Ag–CuO, LaCoO$_3$ (LC), La$_{0.6}$Sr$_{0.4}$CoO$_3$–δ (LSC), La$_{0.6}$Sr$_{0.4}$FeO$_3$–δ (LSF), (La$_{0.6}$Sr$_{0.4}$)$_{0.99}$Co$_{0.2}$Fe$_{0.8}$(LSCF), and La$_{0.75}$Sr$_{0.25}$Cr$_{0.97}$V$_{0.03}$O$_{3}$–δ (LSCrV)) were prepared and characterized with respect to sinterability, oxygen permeation rate, phase interaction, and microstructure. These factors are important when considering the development of composite membranes with CGO as the oxide ion conducting phase. Composite membranes with relative densities >91% were fabricated using conventional powder mixing and sintering or in the case of CGO/Ag–CuO with liquid metal infiltration. Oxygen permeation fluxes across the composite membrane disks were measured as a function of temperature with air on the feed side and varying N$_2$/air mixtures on the permeate side. No chemical reaction between CGO and the other materials were detected by X-ray diffraction. The highest flux of $1.53 \times 10^{-7}$ mol cm$^{-2}$ s$^{-1}$ (0.21 Nm$^{-2}$ min$^{-1}$) at 800°C under N$_2$/air was obtained for a CGO/LSC composite with a thickness of ca. 1mm. The oxygen flux of the CGO/LSC membrane exhibited no degradation after 300h of operation. The results indicate a promising prospect for further tailoring and optimization of CGO-based composites for application in oxygen separation.