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Dual phase composites for tubular oxygen transport membranes

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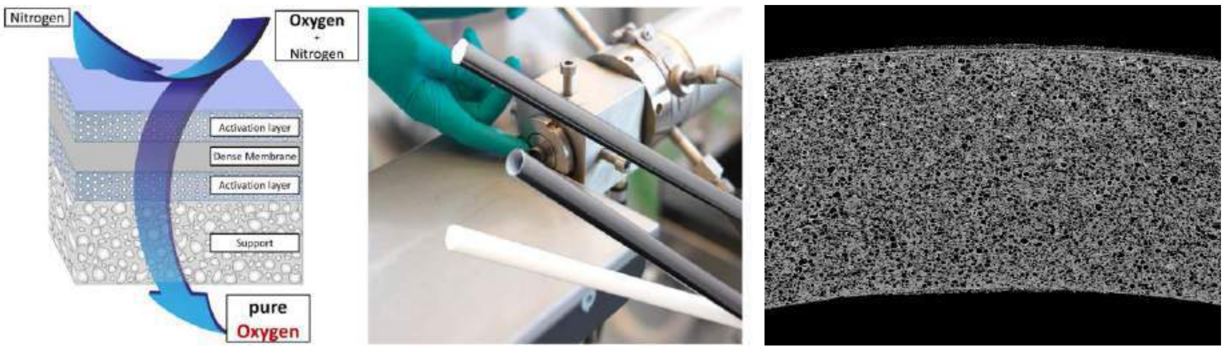
Dual-phase composites based on ionic-conductors (e.g. ceria and zirconia based materials) and electronic conductors (e.g. perovskites) have demonstrated to be suitable materials for oxygen transport membranes (OTM). Chromite perovskites are promising candidates to be used in OTMs, due to their high electronic conductivity, thermo-chemical stability at high temperatures (~1000 ºC) and in reducing environments (pO_2 ~10^{-20} atm). However, their chemical compatibility with ion-conductors in OTMs configuration needs to be further investigated.



a) Schematic illustration of an oxygen transport membrane. b) Tubular oxygen transport membranes developed at DTU Energy. c) SEM cross section of a tubular oxygen transport membrane.

Composites consisting of 30 vol.% perovskites $LaCr_{0.85}Cu_{0.10}Ni_{0.05}O_{3-\delta}$ (LCCN) and $Y_{0.8}Ca_{0.2}Cr_{0.8}Co_{0.2}O_3$ (YCCC), and 70 vol.% ionic conductors $Zr_{0.802}Sc_{0.180}Y_{0.018}O_{2-\delta}$ (10Sc1YSZ) and $Ce_{0.9}Gd_{0.1}O_{1.95}$ (CGO10) were chosen as materials. Composites were sintered in air at 1300 ºC and stability tests in humidified forming gas at 900 ºC for 24 hours were carried out. SEM-EDS and XRD analyses were performed and possible explanations of the degradation mechanism were put forward.

In 10Sc1YSZ-containing composites, low densification, decomposition of the perovskites due to mobility and evaporation of transition metals in the B-side, Ca mobility in YCCC, as well as formation of a La/Zr insulating phase in LCCN were found. In contrast, CGO10-based samples showed > 90% of relative density and higher stability towards reducing conditions. Oxygen permeation tests were performed in both, CGO10-YCCC and CGO10-LCCN composites. Oxygen fluxes up to 0.4 $Nml \cdot cm^{-2} \cdot min^{-1}$ (0.3 $\mu mol \cdot cm^{-2} \cdot s^{-1}$) were obtained at 950ºC in air/N_2 gradient when using 1 mm thick pellets. These results indicate that CGO10-based dual-phase composites are promising OTM materials which require further research for improvement.

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