Oxygen transport in mixed conducting composite materials
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Mixed ionic-electronic conducting ceramic oxides have the potential to meet the supply demands of many applications requiring pure oxygen. Perhaps the biggest and of most commercial importance use for such materials is as membrane reactors for the conversion of gas to liquid fuels, particularly the conversion of natural gas to synthesis gas[1]. Single phase materials of the perovskite structure have most often proposed by many authors as the prime choice due to their ability to accommodate large changes in stoichiometry resulting in attractive oxygen permeabilities. However, under the required operating conditions, practical problems associated with chemical expansion of the crystal lattice often leads to their degradation and/or decomposition. A logical alternative to these materials would be to use composites consisting of coupled ionic and electronic phases analogous to those successfully demonstrated as cathodes for high temperature SOFC's.

Knowledge of the oxygen transport mechanisms in these systems is crucial to any studies involving the optimisation of oxygen fluxes through these membranes. Previous work[2, 3] on the experimental determination of the effective oxygen transport rates on a model system based on composites of LSM-YSZ has shown that, on a macroscopic level, these materials can be treated similar to single phase materials. However, the data further seemed to suggest a change in our understanding of the mode of oxygen transport in these dual phase conductors.

In this paper, we report the electrical conductivity and oxygen permeability measurements on selected LSM-YSZ composites to aid develop a suitable model in light of oxygen transport in mixed conducting composites. Each membrane was tested successfully for a period of greater than 200 hours at temperatures in the range 1073-1273K. The composites were shown to exhibit good oxygen permeation properties in comparison to the individual parent phases and the limiting step found for all materials investigated in the series, was ascribed to the bulk contribution in each. These results would mirror the high transport rates for oxygen diffusion and surface exchange determined in earlier studies on these materials using the IEDP SIMS method[2, 3].

References:

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