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Composite CO_2 Separation Membranes: Insights on Kinetics and Stability

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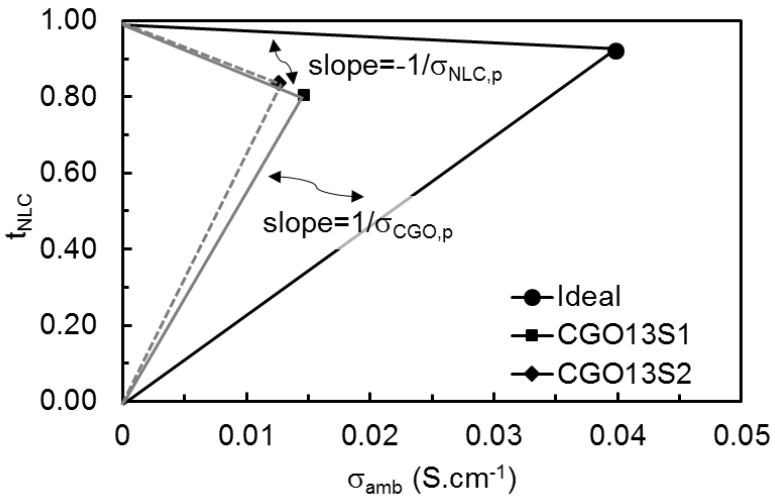
Abstract

The electrical performance and CO_2 permeation of composite membranes based on Gd-doped ceria skeletons impregnated with molten alkaline carbonates are benchmarked against their predictable performance based on ambipolar conductivity governed kinetics (best scenario), using customized diagrams. Experiments performed in the 550-850 °C temperature range showed permeation rates reaching almost 0.6 $cm^3.min^{-1}.cm^{-2}$ at 850 °C with 50 mol% CO_2 content in the feed side. Endurance tests performed at 650 °C for over 100 h showed a small degradation due to microstructural changes. Impedance spectroscopy measurements combined with microstructural analysis involving several composite membranes and skeletons after distinct thermal history confirmed the potential of these techniques to monitor the ceramic skeleton and membrane condition. The diagrams used to map membrane performance highlight in an entirely novel manner several kinetic and experimental constraints.

Graphical abstract



Benchmarking the electrical microstructure of composite membranes