



Solid electrolytes and electrical interconnects for oxygen delivery devices

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Received 20 July 2004; revised 3 August 2005; Accepted 8 August 2005. Available online 6 September 2005.

Abstract

High-purity oxygen can be produced using solid electrolytes, which allow oxygen migration under the influence of an externally applied electrical field, as governed by the Nernst relationship. Planar solid electrolyte oxygen separation (SEOS) technology uses lanthanide doped ceria as the electrolyte and electrically conductive lanthanum alkaline-earth manganites as the electrical interconnect between electrolyte plates. An inexpensive method for making electrolytes and interconnects is required to make this technology commercially viable.

Ceria powder was mixed with Y, Gd, or Sm to achieve high ionic conductivity and a variety of sintering aids were explored. Titanium at a dopant level of less than 2 mol.% increases the sintering activity of $\text{Ce}_{1-x-y}\text{Ln}_x\text{Ti}_y\text{O}_{2-d}$ electrolytes. A reactive sintering approach permits the use of inexpensive ceria, lanthanide, and titania powders to produce a solid solution in-situ. Biaxial stress testing of as-fired electrolytes was used to evaluate the sintered strength as a function of grain size. The effect of grain size on ionic conductivity is reported.

The interconnect should have minimal ionic conductivity, low electrical resistivity, acceptable strength, and be expansion-matched to minimize thermal stresses upon cooling. Lanthanum alkaline-earth manganites ceramics satisfy these requirements by careful tailoring of their chemistry. The strength and modulus are significantly improved by substituting Ca^{2+} for Sr^{2+} in the structure. The substitution of Ca^{2+} for Sr^{2+} lowers the sintering temperature without compromising electrical conductivity. Thermal expansion was matched to the electrolyte at $\text{La}_{0.4}\text{Ca}_{0.6}\text{MnO}_3$. Sintering temperatures below 1400 °C produce high-density interconnects with acceptable properties for operation in SEOS devices.

Keywords: Solid electrolyte; Electrical interconnect; Oxygen delivery; Sintering; Ionic conductivity

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