CGO coatings

CGO barrier layer for fuel cell applications

Introduction

Gd_2O_3-doped CeO_2, abbreviated CGO, is an electrically insulating ceramic coating with high oxygen ion conductivity. A combination of these properties make a CGO coating well-suited as ion conducting electrolyte barriers in solid oxide fuel cells (SOFC) or oxygen separating membranes for gas purification. Novel SOFCs are typically based on an yttria-stabilized zirconia (YSZ) electrolytes and a lanthanum strontium cobaltite (LSC) or lanthanum strontium cobalt ferrite (LSCF) cathode. Strontium from the cathode reacts readily with zirconium in YSZ forming strontium zirconate ($SrZrO_3$) which is a poor ion conductor. To prevent this reaction a barrier layer is applied between the YSZ electrolyte and the cathode. CGO is excellent for this purpose as it effectively stops strontium (Sr) diffusion.

The present CGO coating is well characterized and reproducibly deposited by a reactive physical vapour deposition (PVD) process. The CGO thin films can be deposited on both metallic and ceramic SOFC components and oxygen separation membranes. Depending on the substrate morphology the thickness of the applied CGO film is typically between 0.5 - 3 µm.

Applications

CGO is known to effectively prevent the formation of strontium zirconates ($SrZrO_3$) in the electrolyte/cathode interface which otherwise cause severe deactivation of Sr/Zr-based SOFCs. Moreover, the ionic conductance of CGO is one to two orders of magnitude better than for YSZ. By PVD a thin and dense CGO coating can be deposited. Significant improvement of cell performance has been observed by applying the CGO coating technology developed at the Tribology Centre, Danish Technological Institute [1].

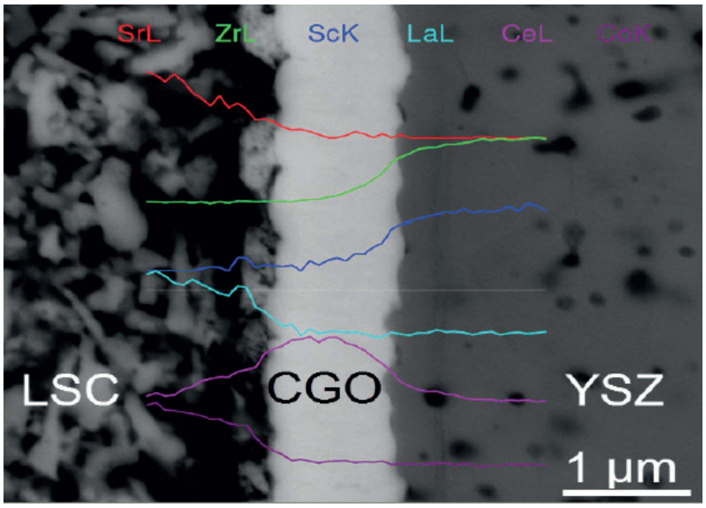

Figure 1:
Scanning electron micrograph and energy-dispersive X-ray (EDS) linescan across the CGO barrier obtained after fuel cell operation. EDS show the chemical composition across the barrier. Note the top red line shows the Sr content to be high in the LSC cathode but the CGO barrier successfully blocks Sr diffusion to the Sc-doped YSZ electrolyte.

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QUALITY SYSTEM CERTIFICATION DNV ISO 9001

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Properties

CGO	
Sample sizes	Typically 13×13 cm^2 but up to 21×40 cm^2
Deposition temperature	400 °C
Composition	$Ce_{0.9}Gd_{0.1}O_{2-\delta}$
Thickness	From 0.5 - 3 µm depending on application and substrate
Crystal structure	Highly crystalline, cubic structure
Performance	Area specific resistance (ASR) of SOFC with CGO barrier measured at 650°C: **0.27 Ωcm²** ASR of similar system without barrier: **0.56 Ωcm²** [1]
Application temperature	Typically below 1000 °C as a barrier between YSZ and LSC

Table 1: *Overview of characteristic performance parameters. [1] J. of Power Sources 196 (2011) 9459–9466.*

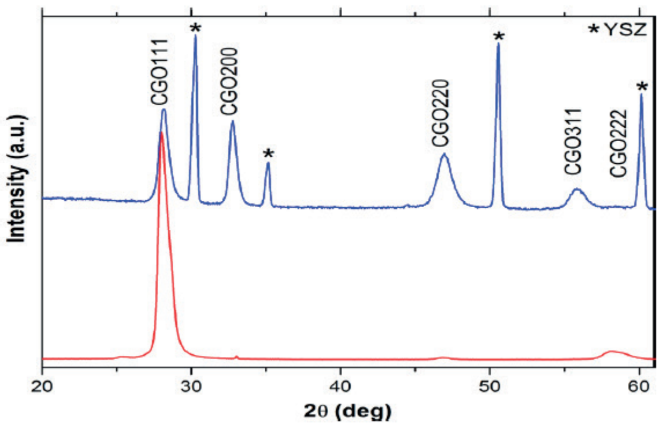

Figure 2

X-ray diffractograms of CGO coatings deposited on Si(001) (red curve) and YSZ electrolyte (blue curve). The diffractograms shows the films are crystalline and cubic. When depositing on YSZ the film is randomly orientated just as the substrate.

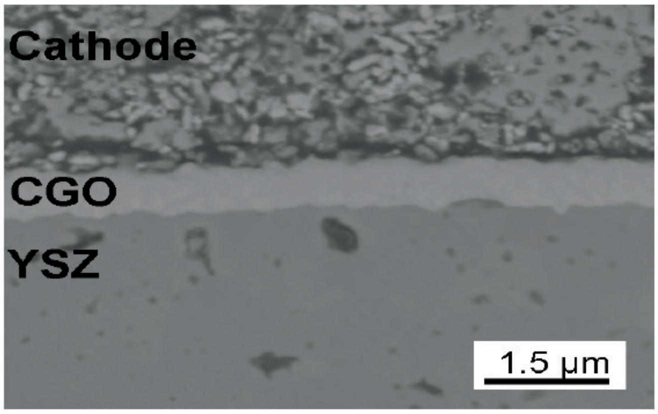

Figure 3

Scanning electron micrograph showing a SOFC cross section. The micrograph shows the deposited CGO film sandwiched between an YSZ electrolyte and a cathode. The CGO barrier is dense and defect free and effectively prevents strontium from the cathode from reacting with zirconium in the electrolyte.

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