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SPUTTER DEPOSITION OF OXIDE THIN FILMS FOR SOLID OXIDE FUEL CELLS

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Application of thin film solid electrolytes for solid oxide fuel cells (SOFCs) is a potential way to improve their competitiveness by reducing the operating temperature and optimizing the efficiency while maintaining long-term reliability. Yttria stabilized zirconia (YSZ) is a common material for this purpose. Often, in a practical situation, it needs to be combined with a gadolinia-doped ceria (CGO) barrier layer to prevent interdiffusion of strontium from the cathode and gas penetrating the electrolyte via pinholes.
This presentation focuses on synthesis and characterization of YSZ and CGO films as well as YSZ/CGO bi- and multilayer for SOFC applications. All films are produced using an industrial-scale coating unit (CemeCon CC800/Sinox) applicable for medium scale production. In addition to tailoring the inherent properties of the film, the adhesion and compatibility with the underlying substrate must be ensured. Deposition has been carried out with traditional YSZ anodes and electrolytes as substrates in addition to Si samples for easy characterization.
The YSZ and CGO thin films were deposited by reactive pulsed DC magnetron sputtering from $Zr_{0.84}Y_{0.16}$ and $Ce_{0.9}Gd_{0.1}$ targets, respectively. XRD, TEM and SEM characterization showed that dense films could be grown with a cubic fluorite crystal structure. The texture could be controlled through bias and temperature variations. For YSZ films a mixed texture was obtained at high negative bias voltages (≥90 V), <220> texture at intermediate voltages of 50-70 V, and <200> texture at low bias voltages (≤40 V). The CGO films were highly <111> textured unless deposited at both low bias and temperature where a mixed texture was seen. When depositing CGO on YSZ substrates or sputtered YSZ in multilayer structures, template effects were seen as the texture of the CGO layer followed the texture of the underlying YSZ layer and vice versa. The absence of pinholes in the deposited films was evidenced by gas testing.

Keywords
Reactive sputtering
Solid oxide fuel cell
YSZ
CGO