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Study on yttria stabilized zirconia electrolyte and gadolinia-doped ceria barrier layer deposited by d.c. magnetron sputtering under reactive conditions

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In high temperature electrolysis systems (about 700°C), deleterious reaction involving degradation of the performances often occurs between the cell materials used as electrode and electrolyte. As an example, the interfacial reactions between YSZ (electrolyte) and LSCF (anode) can lead to La2Zr2O7 and/or SrZrO3 phase formation. To limit this reactivity, a gadolinia-doped ceria interlayer must be deposited between YSZ and LSCF. This thin barrier layer (< 500 nm) can be deposited by magnetron sputtering under reactive conditions.
In this work, both yttia stabilized zirconia and gadolinia-doped ceria deposits were manufactured by direct current magnetron sputtering under reactive conditions. Films were deposited on various substrates (i.e. silicon wafer, NiO-YSZ cermets, glass plates). The main characteristics (crystallinity, composition, density, oxygen content) were studied by scanning electron microscopy (SEM), electron dispersive spectroscopy (EDS), X-ray diffraction (XRD), Rutherford backscattering spectroscopy (RBS) and optical transmission.
First, working conditions in elemental sputtering mode were adjusted to ensure a high deposition rate. A set point just before the transition was chosen to increase the oxygen content in the deposits. Then, classical ex situ or in situ heat treatments were performed to fully oxidize the deposits. The subsequent volume expansion was also investigated regarding the as previously determined deposition conditions to obtain oxide layers as dense as possible without stress cracking.
Finally, YSZ electrolyte and CGO barrier layers were successively deposited in the sputtering chamber. A particular attention was paid to optimize the YSZ/CGO interface in order to promote adhesion between the layers and the global ionic conductivity thanks to a smooth transition between YSZ and CGO.

Keywords
d.c. magnetron sputtering / gadolinia-doped ceria (CGO)
reactive conditions / heat treating / stress cracking