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Synthesis and characterization of La2NiO4-δ coatings deposited by reactive magnetron sputtering using plasma emission monitoring

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Rare-earth nickelates with K_2NiF_4 –type structure, namely $Ln_2NiO_{4-\delta}$ (Ln= La, Pr, Nd) are assumed to be promising cathode materials for Intermediate Temperature- Solid Oxide Fuel Cell (IT-SOFC). Such materials exhibit both high mixed ionic-electronic conductivity (MIEC) properties and high catalytic activity. Their thermal expansion coefficient (TEC) is very close to that of electrolyte materials (13 $x10^{-6}$ K^{-1}, 11.9 $x10^{-6}$ K^{-1} and 11.6 $x10^{-6}$ K^{-1} for La_2NiO_4, CGO and YSZ respectively). Using MIEC material allows transforming the common triple-phase boundary cathode into a double contact (solid conductor/gas phase) and lowering the cathode polarization. Therefore, the deposition of a dense cathode layer providing a fine microstructure with high electrochemical properties may be manufactured by reactive magnetron sputtering.
$La_2NiO_{4-\delta}$ coatings were co-sputtered by reactive magnetron sputtering on different substrates from metallic La and Ni targets in the presence of a reactive argon-oxygen gas mixture. The reactor is a 100-litre sputtering chamber pumped down via a turbo molecular pump allowing base vacuum of about 10^{-4} Pa. The deposition stage is controlled by Plasma Emission Monitoring (PEM) which consists in monitoring the reactive gas flow in order to maintain constant the optical emission of a metallic species (in this case La), which is proportional to the sputtered metal flow. Once determined the composition to synthesize stoichiometric La_2O_3, the discharge current on the nickel target is adjusted to obtain the convenient composition for lanthanum nickelate. Whatever their composition, the as-deposited coatings are amorphous, and crystallize under K_2NiF_4 structure with appropriate annealing temperature. The structural and chemical features of these coatings have been determined by X-Ray Diffraction and Scanning Electron Microscopy. Their electrical properties were evaluated using four points probe method and Electrochemical Impedance Spectroscopy (EIS).

Keywords
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electrical properties