Preparation of a tubular, metal supported, Sm-doped Ceria oxygen permeable membrane via RF Sputtering

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Introduction

The objective of this work is to develop a dense, defect-free, tubular samarium-doped ceria oxygen-permeable membrane [1] $Ce_{0.8}Sm_{0.2}O_{2-\delta}$ using radio frequency sputtering (Figure.1,2,3) and electrophoretic deposition (EPD) techniques, employing a porous **AISI 316** tubular steel as the support.

Experimental section

In order to provide an adequate surface for the deposition of the membrane film, a proper **$ZrO_2/La_{0.6}Sr_{0.4}Fe_{0.2}Co_{0.8}O_3$** ($ZrO_2$/LSFC) porous composite interlayer was deposited on a porous metal support by electrophoretic deposition technique, followed by annealing at 950°C for 5h. The samarium doped ceria (SDC) layer [2] was sputtered in **$Ar+O_2$** atmosphere at a RF power of **200 W** and working pressure of **0.53 P**a on the cylindrical support previously coated by ZrO_2/LSFC. A homemade rotating sample holder (Figure 2) was used to guarantee the uniformity of the coating. SEM images showed a uniform morphology of the coatings without surface cracks, even after annealing at 950°C. Membranes performances will be tested in a water-cooled dielectric barrier discharge reactor.

Figure 1. MRC 8620 Radio Frequency Sputtering System

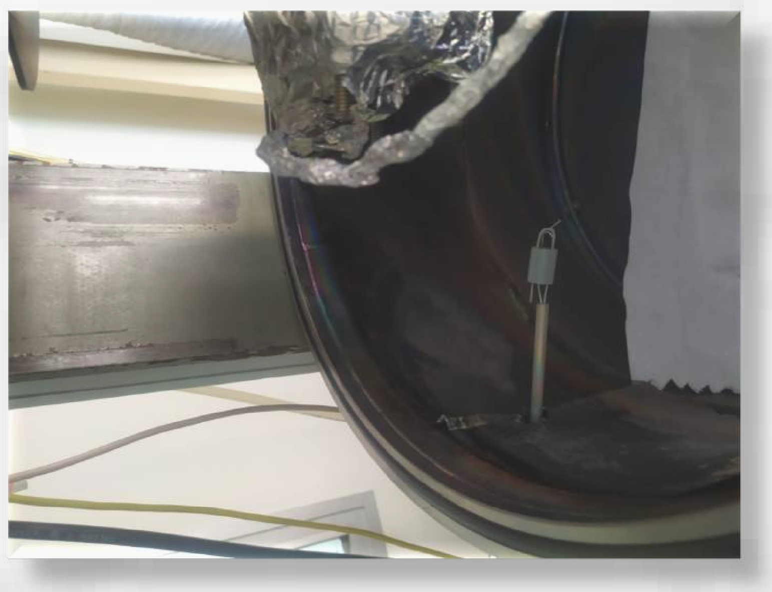

Figure 2. Deposition chamber with rotable membrane support

Figure 3. Plasma generated during deposition from the Sm doped ceria target.

Results

A porous **AISI 316** tube, with pores ranging from 10 µm to 20 µm, was employed in this study as the oxygen membrane support. In order to close the surface porosity of the support and allow the deposition of a dense and defect-free DSC membrane by RF sputtering, a $ZrO_2/La_{0.6}Sr_{0.4}Fe_{0.2}Co_{0.8}O_3$ porous interlayer was deposited on the tubular support by electrophoretic deposition. Figure 4 shows the picture of the composite membrane and Figure.5 shows the FE-SEM micrographs at different magnifications. No evident cracks, even after annealing at 950°C, were found.

Figure 4. Membrane

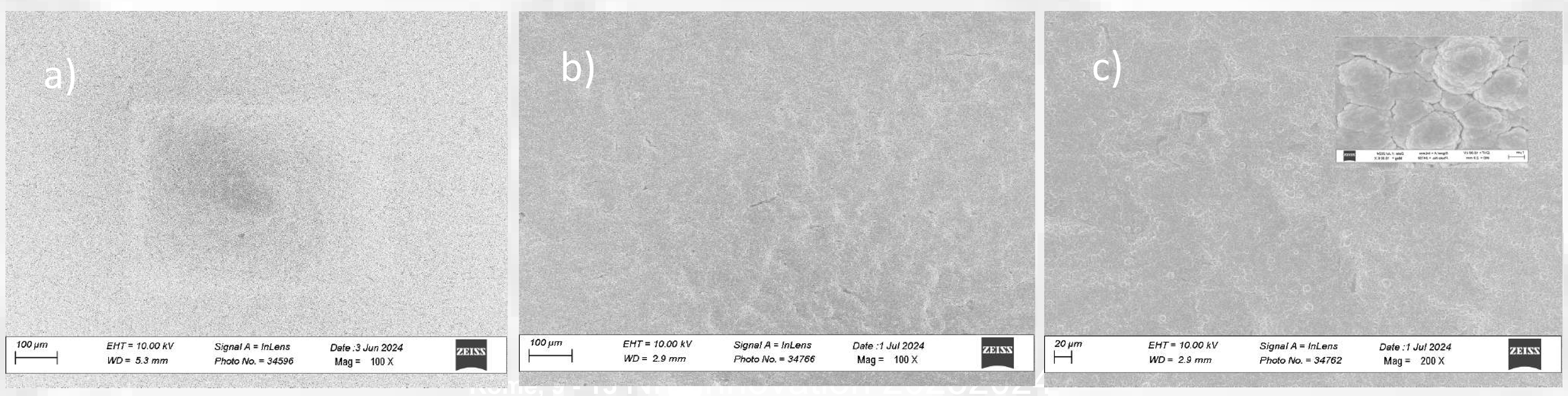

Figure 5. SEM images of SDC/ZrO_2/LSFC membrane on AISI 316 at different magnifications. a) ZrO_2/LSFC, b) SDC ZrO_2/LSFC membrane 100 X, c) SDC ZrO_2/LSFC membrane 200 X.

Conclusions

A $Ce_{0.8}Sm_{0.2}O_{2-\delta}$ oxygen membrane, defect free, was successfully fabricated on a AISI 316 tubular porous support by combing RF sputtering and electrophoretic deposition. To reduce the porosity of the metal support and allow the deposition of a dense membrane, the support was previously coated by an electrophoretic $ZrO_2/La_{0.6}Sr_{0.4}Fe_{0.2}Co_{0.8}O_3$ interlayer. SEM images confirmed that the membrane is defects-free. The test in oxygen permeability membrane will be carried out in a DBD plasma reactor.

References

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Acknowledgments

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