Artificial mixed ionic electronic conductors by grain boundary engineering

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Nanoionics has become an increasingly promising field for the future development of advanced energy conversion and storage devices, such as batteries,fuel cells, and supercapacitors. Particularly, nanostructured materials offer unique properties or combinations of properties as electrodes and electrolytes in a range of energy devices. However, the enhancement of the mass transport properties at the nanoscale has often been found to be difficult to implement in nanostructures. In this talk, we will detail the fabrication of an artificial mixed ionic electronic conducting oxide obtained by grain boundary (GB) engineering thin films of $La_{0.8}Sr_{0.2}MnO_{3+\delta}$. This electronic conductor is converted into a good mixed ionic electronic conductor by synthesizing a nanostructure with high density of vertically aligned GBs with high concentration of strain-induced defects. Since this type of GBs present a remarkable enhancement of their oxide ion mass transport properties (of up to six orders of magnitude at 773 K), it is possible to tailor the electrical nature of the whole material by nanoengineering, especially at low temperatures. Complementary, we will analyse the effect of the GB contribution to the mass transport properties of other interface-dominated thin films that show initial mixed ionic electronic conduction, e.g. $La_{0.8}Sr_{0.2}CoO_{3-\delta}$. A comprehensive work of the LSMC family fabricated with combinatorial Pulsed Laser Deposition ($La_{0.8}Sr_{0.2}Mn_xCo_{1-x}O_{3-\delta}$, x=0-0.8) will be discussed. The results of this study leads to fundamental insights into oxygen diffusion along GBs and to the application of these engineered nanomaterials in new advanced solid state ionics devices such are micro-solid oxide fuel cells or resistive switching memories.