

The origin of mixed ionic-electronic conduction in grain boundary dominated strontium-doped lanthanum manganite thin films

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The development of functional metal oxide thin films with superior mixed ionic-electronic conduction is of primary importance for a broad deployment of many miniaturized energy devices, such as micro Solid Oxide Fuel cells (μ SOFC). Among the different approaches proposed in literature, interface-dominated thin films have been shown as a promising solution for the enhancement of oxygen mass transport properties. As an example of that, recent studies showed that grain boundaries in Sr-doped LaMnO_3 (LSM) thin films present a large increase of oxygen diffusion and surface exchange coefficient with respect to the bulk ^{1,2}. In this study, the origin of this great enhancement is investigated. The grain boundary structure and composition of polycrystalline LSM thin films deposited by pulsed laser deposition (PLD) has been characterized by High-resolution Transmission Electron Microscope (HR-TEM) and electron energy loss spectroscopy (EELS). The analysis revealed that a high density of dislocations occurs at the interface between grains with different orientations, along with a rearrangement of cationic composition. Also, the grain boundaries show oxygen deficiency which, opposed to the typical hyper-stoichiometry present in bulk LSM, appears to be the origin of the enhanced mass transport properties. Finally, we confronted the electronic resistivity as a function of temperature of a polycrystalline and an epitaxial LSM thin film grown under similar conditions. The difference in the behavior obtained is coherent with the strong chemical and structural defects presents at the grain boundaries. In conclusion, the complex local defect chemistry that governs the grain boundaries changes the nature of the LSM thin film, promoting the oxygen transport, but at the same time is detrimental for the electronic properties.

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