Changing Ionic and Electronic Conductivity of Sr-doped $LaMnO_3$ Thin Films by Grain Boundary Engineered

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Sr-doped lanthanum manganite is the most commonly used cathode material in SOFCs. Nevertheless, many aspects of oxygen reduction at LSM electrodes are not yet fully understood. Particularly important in this respect is the long time stability and degradation effects upon the oxygen reduction kinetics. By understanding the mechanism and determining factors related to the diffusive properties, faster oxygen transporting and more stable thin films can be designed, respectively. Much attention has recently been focused on the oxygen reduction via LSM grain boundaries since their oxygen transport is 1000x faster and their surface incorporation is also nearly 1000x higher than the LSM bulk [1]. Additional the electronic conductivity of the same LSM thin films were investigated under the same experimental conditions. Grain boundaries and changing microstructure as well as strain were found to influence electronic charge transport heavily. By combining the results from ionic and electronic conduction of LSM thin films with different micro structures, predictions can be made and limitations can be shown for grain boundary engineering in the field of mixed ionic electronic ionic conductors (MIEC).

In this work, LSM thin films were deposited by pulsed laser deposition and analyzed by ToF-SIMS, Van der Pauw and impedance spectroscopy. ^{18}O tracer exchange experiments were performed in a novel operando experimental design to study the influence of cathodic bias upon surface exchange and transport properties of both LSM grains and grain boundaries. SIMS profiles showed a large increase in ^{18}O concentration in the LSM films with an apparent uphill diffusion [2]. Such experiments require specially designed exchange equipment and a high degree of user expertise. Therefore an alternative experimental design was developed which could be performed in conventional oxygen exchange chambers to study the influence of polarization in-operando. This new experimental design facilitates the ability to investigate several voltage changes in every required voltage region under SOFC operation conditions within one thin film. The apparent uphill diffusion could be simulated by a 3D finite element model with two parallel and interacting diffusion pathways.

References

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