Versatile and efficient controls of reversible topotactic transitions in complex oxide thin films

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Topotactic phase transition of perovskite oxides facilitate fast and reversible oxygen transport, which is advantageous for many energy and device applications. Controlling the profiles of ions and vacancies provides a new route toward novel phenomena and functionalities. However, the oxygen-diffusion mechanism during the transition remains elusive due to the lack of generally applicable technique for the quantitative determination of oxygen stoichiometry. In our study, various approaches of thermal annealing, chemical reduction, ion implantation, and liquid-electrolyte gating are employed to trigger the topotactic transition in epitaxial $La_{0.7}Sr_{0.3}MnO_{3-\delta}$ thin films. Through advanced scattering methods (neutron, x-ray, electron and ion-beam), the interplay between electronic, magnetic, and ionic properties is addressed at the oxide interface. A precise determination of oxygen concentrations and their gradients is achieved for the first time in topotactic phases. The revealing oxygen-diffusion mechanism contributes a crucial factor in the field of defect engineering and provide foundation for manipulation of oxygen transport kinetics in solid oxide fuel cells.

Reference:

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