The structural study of $\text{La}_{0.9}\text{Sr}_{0.1}\text{Co}_{1-x}\text{Fe}_x\text{O}_{3-\delta}$ through \textit{in situ} neutron and synchrotron diffraction

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To understand the complex structural evolution of oxygen transport membranes such as $\text{La}_{0.9}\text{Sr}_{0.1}\text{Co}_{1-x}\text{Fe}_x\text{O}_{3-\delta}$ ($x = 0, 0.25, 0.75, 1$) (LSCFO) under industrially relevant conditions \textit{in situ} neutron and synchrotron diffraction data was collected and quantitatively analyzed via Rietveld refinements. Both temperature and gas atmospheres were modulated, and the weight percents of all intermediate phases were determined. These experiments led to a structural mechanism in the cobalt-rich phase that transforms the perovskite structure into the layered Ruddlesden Popper phase through exfoliation of the layers and liberation of a B-site oxide. Cobalt-rich phases formed reduction products at earlier temperatures than iron-rich phases and showed significantly different phase transitions during reactions, providing mechanistic insights into what phases are catalytically active at specific conditions. All systems showed redox cycling despite multiple structural phases being present throughout the redox process. This study gives insight into the structural changes accompanying redox reactions in oxygen transport membranes and how to utilize \textit{in situ} diffraction measurements to study industrially relevant systems under extreme conditions.