# An Investigation into the Phase Formation, Ionic Conductivity, Surface Oxygen Exchange, and Long-Term Stability of Sr-Doped versus Undoped $LaFeO_3$ Composites with Gadolinium-Doped Ceria

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Mixed ionic-electronic conducting (MIEC) perovskites are critical materials for high-temperature applications such as oxygen separation membranes and cathodes for solid oxide fuel cells (SOFCs), operating between 700-900 °C. The long-term operational stability of these materials is often compromised by structural, microstructural, and chemical degradation. A primary failure mechanism in conventionally used perovskites like $La_xSr_{1-x}FeO_3$ (LSF) is the surface segregation of the A-site dopant, strontium (Sr). This phenomenon, driven by lattice strain and electrostatic attraction to surface oxygen vacancies, leads to the formation of an insulating $SrO/Sr(OH)_2$ layer, which passivates the electrocatalytically active surface and severely hinders oxygen exchange reactions, thus degrading performance.

This study re-evaluates the conventional approach of A-site doping by investigating a simplified, Sr-free material chemistry aimed at preventing surface segregation. While Sr-doping is known to create charge-compensating defects ($V_o^{..}$ and $h^{.}$) that initially boost performance, this work explores the potential for undoped perovskites to exhibit superior long-term stability. By maintaining a clean, active surface free from SrO passivation, the sustained performance of the Sr-free material could ultimately match or exceed that of the doped material.

In this work, Sr-doped and undoped $LaFeO_3$ powders, as well as their composites with Gadolinium-Doped Ceria (GDC), were synthesized using the Pechini method. The microstructure and phase composition were analyzed using Scanning Electron Microscopy (SEM) and X-ray Diffraction (XRD) on the as-prepared samples and after prolonged thermal exposure at 700°C. Furthermore, the evolution of ionic conductivity and the surface oxygen exchange coefficient was tracked by conducting Electrochemical Impedance Spectroscopy (EIS) and Electrical Conductivity Relaxation (ECR) measurements at 10-hour intervals throughout a 100-hour heat treatment at 700°C.

Dr. Mehmet Sezer completed his undergraduate studies in Metallurgical and Materials Engineering at Istanbul Technical University. Following his graduation, he worked as an engineer for five years in the iron & steel and plastics industries. He then pursued his graduate studies at Gebze Technical University, where he earned both his M.Sc. and Ph.D. degrees in the Department of Materials Science and Engineering. His doctoral research focused on solid oxide fuel cells and oxygen separation membranes. He currently continues his research at the same university on related topics.

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