

119f Investigation of Oxygen-Surface Interactions over Doped Lanthanum Ferrites for Solid Oxide Fuel Cell Cathodes

John N. Kuhn and Umit S. Ozkan

The realization of solid oxide fuel cells (SOFCs) is hindered by their failure to reach performance goals while remaining cost competitive with existing technologies. Current SOFCs operate near 1000°C because state of the art cathodes cannot process molecular oxygen adequately at reduced temperatures. Lowering the operating temperature to at least 650°C would relieve many of the financial burdens plaguing commercialization of SOFCs.

Alternative cathode formulations based on $\text{La}_{1-x}\text{Sr}_x\text{Co}_y\text{Fe}_{1-y}\text{O}_{3-\delta}$ with a perovskite (ABO_3) crystal structure that are capable of activating and transporting molecular oxygen at temperatures between 500°C and 800°C have been developed. The materials were prepared by milling techniques and solid-state reaction. Compatibility with potential electrolyte materials was also confirmed.

The materials are able to withstand deficiencies in bulk oxygen content without undergoing a phase change. Oxygen vacancies are vitally important for the oxygen reduction reaction and diffusion of the oxide ion through the cathode material. In addition to depending on temperature and oxygen partial pressure, the capability of forming oxygen vacancies changes as dopants are introduced into the material. Strontium and cobalt were doped into the A-site and B-site, respectively, of the lanthanum ferrite perovskite materials. Oxygen nonstoichiometry, an indicator of oxygen vacancies, was determined by temperature-programmed reduction and thermogravimetric analyses.

Transient thermogravimetric with simultaneous heat flow data during isothermal oxygen adsorption and desorption allowed for the determination of the surface reaction rate constant and an oxide ion diffusion coefficient. The results are complimented by oxygen isotopic exchange experiments and cyclic voltammetry.

Additionally, trends in these properties are related to physical and chemical variations caused by different strontium and cobalt dopant levels. X-ray diffraction, laser Raman spectroscopy, and Mössbauer spectroscopy were employed to understand these basic phenomena. Unit cell size variations caused by the formation of oxygen vacancies were determined by *in-situ* X-ray diffraction.