Insights into Oxygen Electrochemical Reaction Mechanisms on (La,Sr)MnO_3

Sossina M. Haile

Department of Materials Science and Engineering, Applied Physics Program, and Department of Chemistry, Northwestern University
Email: sossina.haile@northwestern.edu, Web: http://addis.ms.northwestern.edu/

Abstract

Lanthanum strontium manganite is the canonical cathode for solid oxide fuel cells. It offers an attractive balance between electrochemical activity, chemical stability, and thermomechanical compatibility with the widely used electrolyte, yttria stabilized zirconia (YSZ). Despite its widespread implementation, questions regarding the reaction pathway for oxygen electroreduction on this material remain open. Here, a fundamental study of the reduction mechanism is carried using thin film methods. Libraries of $(La_{0.8}Sr_{0.2})_{0.95}MnO_{3+\delta}$ (LSM) thin film microelectrodes with systematically varied thickness or growth temperature were prepared by pulsed laser deposition, and a novel robotic instrument was used to characterize these libraries in automated fashion by impedance spectroscopy. All impedance trends are consistent with a reaction pathway involving oxygen reduction over the LSM surface followed by diffusion through the film and into the electrolyte substrate. The surface activity is found to be correlated with the number of exposed grain boundary sites, which decreases with either increasing film thickness (at constant growth temperature) or increasing film growth temperature (at constant thickness). These findings suggest that exposed grain boundaries in LSM films are more active than boundary-free terminations for the rate-limiting surface process, and that oxygen ion diffusion through polycrystalline LSM films is faster than several prior studies have concluded.

Short Biography

Sossina M. Haile is the Walter P. Murphy Professor of Materials Science and Engineering at Northwestern University, a position she assumed in 2015 after serving 18 years on the faculty at the California Institute of Technology. She earned her Ph.D. in Materials Science and Engineering from the Massachusetts Institute of Technology in 1992. Haile's research broadly encompasses solid state ionic materials and electrochemical devices, with particular focus on energy technologies. She has established a new class of fuel cells with record performance for clean and efficient electricity generation, and created new avenues for harnessing sunlight to meet rising energy demands. Amongst her many awards, in 2008 Haile received an American Competitiveness and Innovation (ACI) Fellowship from the U.S. National Science Foundation in recognition of "her timely and transformative research in the energy field and her dedication to inclusive mentoring, education and outreach," the 2012 International Prize in Ceramics of the World Academy of Ceramics, and the 2010 Chemical Pioneers Award of the Chemical Heritage Foundation. She is a fellow of the Materials Research Society, the African Academy of Sciences, and the Ethiopian Academy of Sciences, and serves on the editorial boards of *Materials Horizons* and *Annual Review of Materials Research*.