**Understanding the Performance of LSCF Based Solid Oxide Fuel Cell Cathodes with Non-Linear Electrochemical Impedance Spectroscopy**

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Non-Linear Electrochemical Impedance Spectroscopy (NLEIS) can be used to distinguish the relative roles of key processes governing SOFC cathode performance. Harmonics measured by the NLEIS technique are sensitive to the specific kinetic mechanism for oxygen reduction, thermodynamic behavior of the bulk and surface of the electrode, and the relative rates of surface transport, bulk transport, and oxygen kinetics. Fundamental understanding of these processes as well as their dependencies on material properties is critical for the engineering of better performing cathode materials.

The behavior of La0.6Sr0.4Co0.2Fe0.8O3-δ electrodes is studied using both Linear EIS and NLEIS, for both a porous and dense thin-film geometry. Nonlinear harmonics and trends in linear characteristics are used to identify the likely kinetic mechanism for oxygen reduction, as well as the thermodynamic behavior of the material.