In situ Synchrotron X-ray Characterization of Potential-dependent Cation Segregation and B-site Surface Oxidation State in Model Thin-film Perovskite Cathodes

Kee-Chul Chang¹, Brian Ingram², Lu Yan³, Paul Salvador¹, and Hoydoo You¹
¹Materials Science and ²Chemical Sciences and Engineering Divisions, Argonne National Laboratory, Argonne, IL 60439
³Department of Materials Science and Engineering, Carnegie Mellon University, Pittsburgh, PA 15213

Solid Oxide Fuel Cells

Electrolyte: Yttrium Stabilized Zirconia (YSZ)
YSZ Electrolyte

Anode: Ni-YSZ Cermet

Cathode: perovskites
Li₀.₆Sr₀.₄MnO₃ (LSM)
La₀.₆Sr₀.₄CoO₃ (LSC)
La₀.₆Sr₀.₄Fe₀.₈Co₀.₂O₃ (LSCF)

EXAFS, XANES, TXRF

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Experimental Setup

Grazing Incidence X-rays – surface sensitivity

In situ electrochemical half cell operates as an oxygen pump

Ex-situ measurements

Thick film cathodes were electrochemically conditioned at 700°C for 72 hours under different potentials to investigate the effects of potential on cation segregation and oxidation state. We used flattened wires with pressure contacts to look at the surface underneath the wire. Inactive wire was used to separate the effects of wire covering the surface. Potential drops away from the active wire.

Sr segregation is evenly spread around the surface but Co segregation is confined near the active wire at -1V

Surface Co oxidation state is also correlated with the Co segregation

Conclusions

LSM/YSZ(111) results

Influence of Au wires

Effect of thin layer of LSM on LSCF/YSZ(111)

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LSM has smaller chemical expansion and slower kinetics

Potential dependent chemical expansion of specular LSCF/(011) on YSZ(111)

In situ Co segregation and surface Co oxidation state change

• our cathodic conditioned sample shows consistent behavior as the other ex situ samples
• we were able to observe Co segregation and oxidation state change during our in situ experiments
• The order of applied potential was different between in-plane (OCP, +1V, -1V) and out-of-plane (OCP, -1V, +1V) measurements
• potential effects are enhanced for out-of-plane configuration