

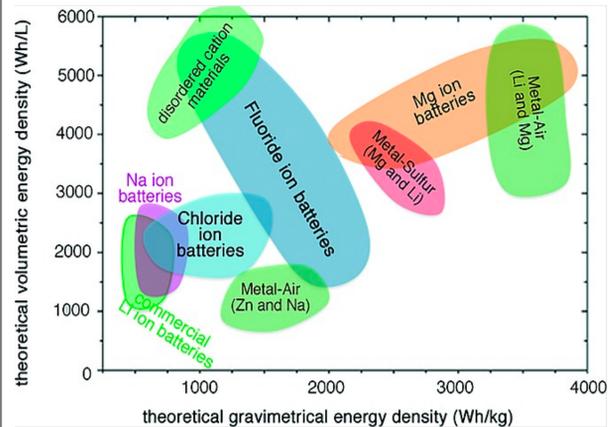
Advanced Materials and Electrochemistry for Energy (AMEE) Research Group

Ö. Özgür Çapraz, Assistant Professor at Oklahoma State University

Research Interest and Challenges

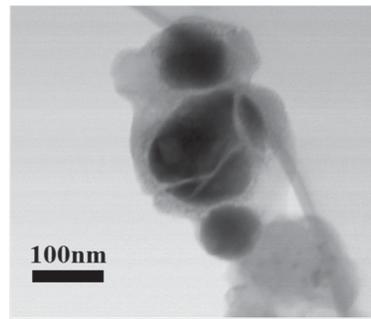
Electrochemical Energy Storage

- Beyond Li-ion Batteries:** Practical performance of beyond Li-ion batteries are much lower than their theoretical ones due to interfacial and structural instabilities associated with reactivity of metal ions with electrolyte and electrodes.



Rodriguez-Garcia et al., EurJC, 2017

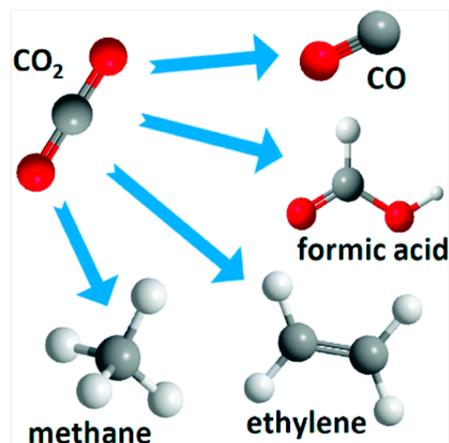
SEM image of Tin-Antimony electrode for Na-ion Batteries (after 80 cycles)



Ji et al., Adv. Mater. (2014)

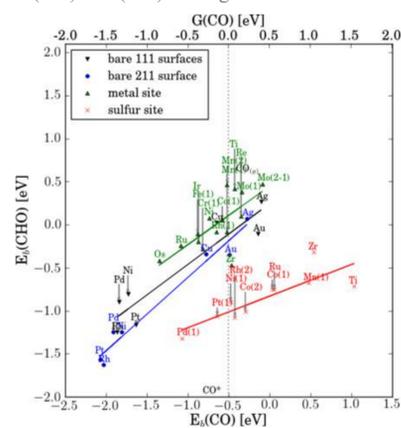
Electrochemical Energy Conversion

- Electrochemical Reduction of CO₂:** Poor selectivity and low efficiency of electrocatalysts are the major problems for converting CO₂ into desirable hydrocarbons.



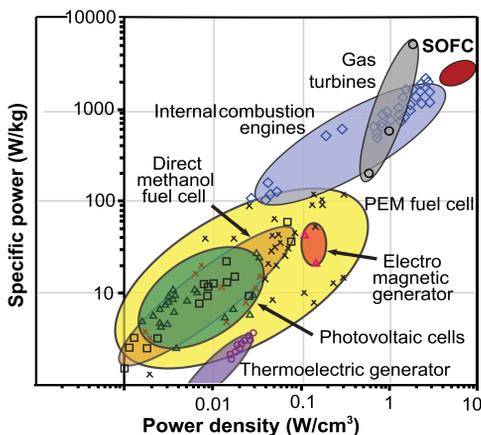
<https://www.greencarcongress.com/2010/12/kenis-20101207.html>

Binding energies for the metal and sulfur site of doped sulfur edge of MoS₂, as well as the transition-metal (111) and (211) scaling relations.



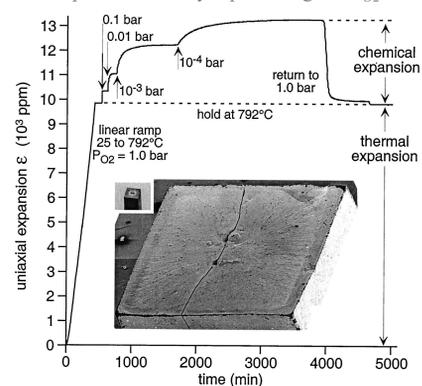
Norskov et al., ACS Catalyst, 2016

- Solid-Oxide Fuel Cells:** Chemo-mechanical instability of solid electrolytes associated with oxygen vacancy formation critically influences lifetime and performance of these fuel cells.



NSF Solid-Oxide Fuel (SOFC) Cell Workshop Report (2013)

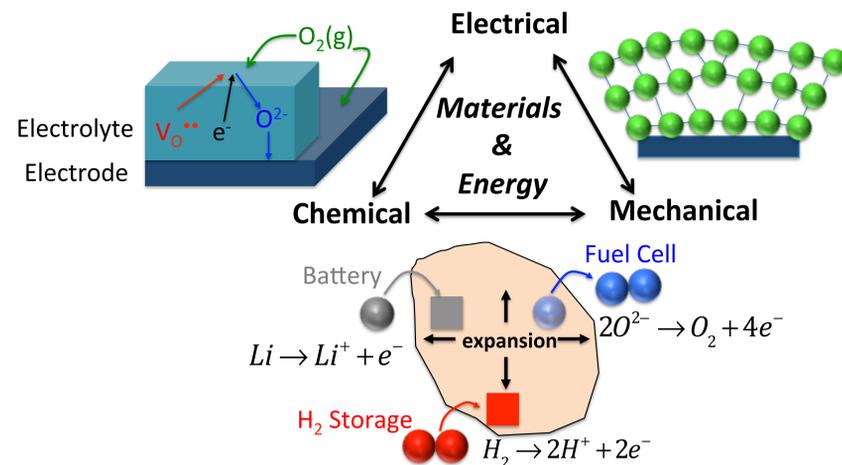
Crack formation in LSCF (La_{1-x}Sr_xCo_{1-y}Fe_yO₃) electrolyte upon excessively rapid change in P_{O₂}



Adler et al., J Am Ceram Soc., 2001.

Overview of Research Group

Electro-Chemo-Mechanical Phenomena in Advanced Materials



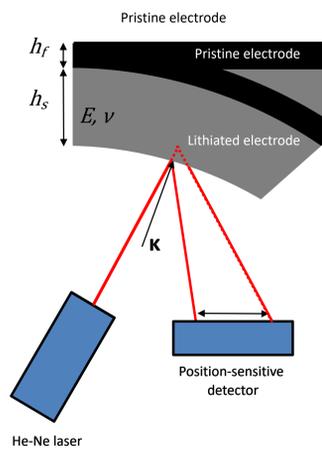
Biosketch of AMEE Research Group

- Established in Fall 2018 in the School of Chemical Engineering at Oklahoma State University
- 2 Ph.D. students, 1 master student and two undergraduate student researchers.
- Currently funded by Oklahoma State University Start-up, the Lew Wentz Foundation, Binational Science Foundation (BSF), and Oklahoma NASA EPSCoR.
- Website: ceat.okstate.edu/che/amee

In-Situ Techniques

Curvature Interferometry

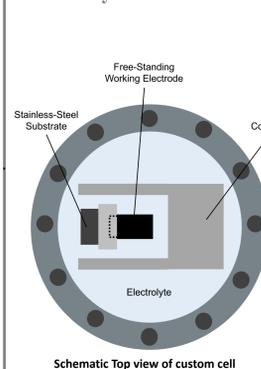
Substrate Curvature + Stoney Formula



Çapraz, J. Electrochem. Soc., 2013

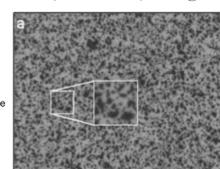
Strain Measurements

Battery Custom Cell

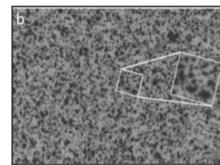


Çapraz, Exp. Mech. Soc., 2019

Undeformed (reference) image



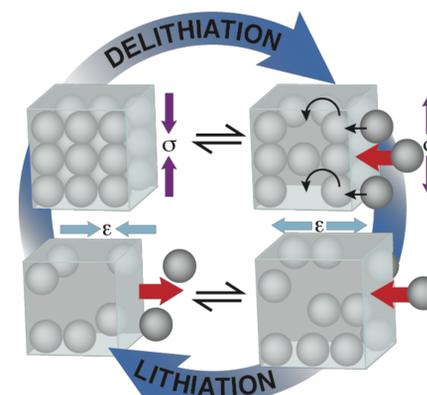
Deformed image



Research Activities

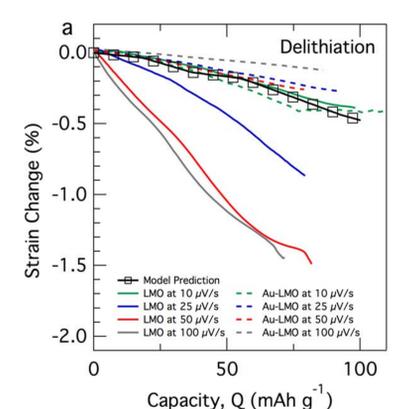
Electrochemical Energy Storage

Chemo-mechanical response of li-ion battery electrodes



Çapraz et al., Adv. Energy Mater., 2017

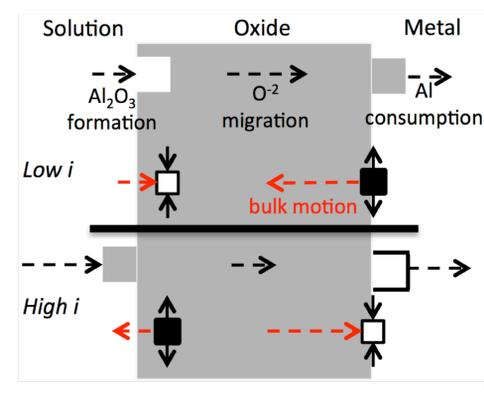
Controlling volumetric expansion of electrodes via surface modifications



Çapraz et al., J. Electrochem. Soc., 2019

Multifunctional NanoMaterials

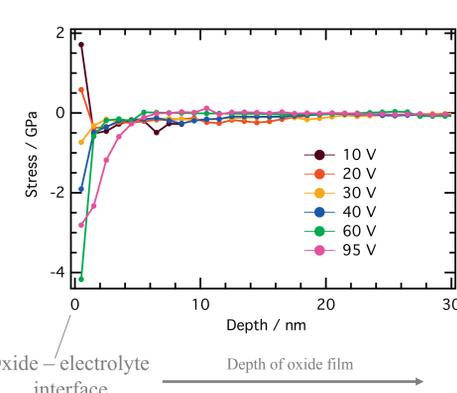
The role of stress in nanoporous anodic oxide film formation



Çapraz et al. Electrochim. Acta, 2015

Defect-induced Stress Generation

Stress built near oxide-electrolyte interface due to anion incorporation



Çapraz et al. Electrochim. Acta, 2015