

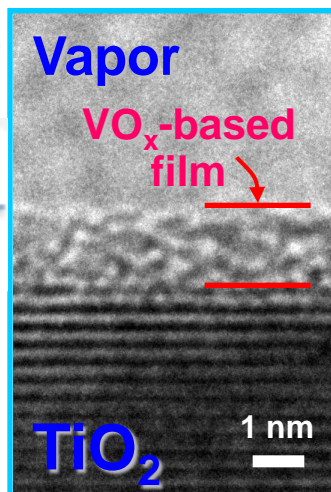
# Interfaces in Materials for Energy Applications

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Clemson

## Oxide Surfaces & Nanoscale Films



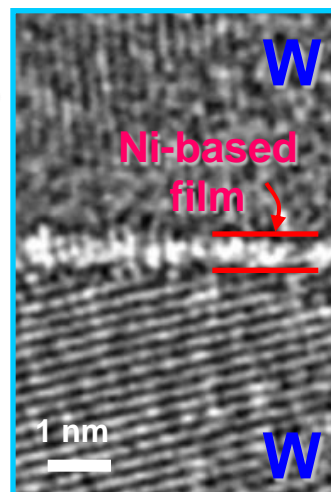
Supported by  
National Science  
Foundation  
CAREER Award  
(2005-2010)



## Refractory Metals & High-T Materials



Supported by  
Air Force Office of  
Scientific Research  
Young Investigator  
Award (2007-2010)



## Grain Boundary Transitions in Silicon

Supported by  
Department of Energy  
Office of Basic Energy Science  
DMSE (2008-2012)



Office of Basic Energy Sciences

### Technological Relevance (Selected):

- Supported oxide catalysts
- Li ion battery cathode materials
- Nanoparticles; Ultrathin dielectrics

### Selected Publications:

- Appl. Phys. Lett. 95: 211905 (2009)
- Annu. Rev. Mater. Res. 38:227 (2008)
- Acta Mater. 56:4702 (2008)
- Acta Mater. 56:862 (2008)
- Appl. Phys. Lett. 91:061909 (2007)
- Mater. Sci. Eng. A 422:19 (2006)
- Langmuir 21:7358 (2005)

### Technological Relevance (Selected):

- High-*T* materials (Mo-Si-B, ceramics)
- Microstructural development
- Nanocrystalline materials (e.g., nano-W for anti-armor applications)

### Selected Publications:

- Crit. Rev. Solid State Mater. Sci. 32: 67 (2007)
- Appl. Phys. Lett. 94:251908 (2009)
- Appl. Phys. Lett. 92:101901 (2008)
- Acta Mater. 55:3131 (2007)
- Appl. Phys. Lett. 87:231902 (2005)

### Technological Relevance:

- Si Solar cells
- Realizing predictable fabrication of materials by design

### Selected Publications:

- Rev. Mod. Phys. 82, 1887 (2010)
- Curr. Opin. Solid State Mater. Sci. 12:81 (2008)
- APL 95:071911 (2009)
- Microscopy Today, 17:22 (2009)
- JOM 61 [12]: 38 (2009)

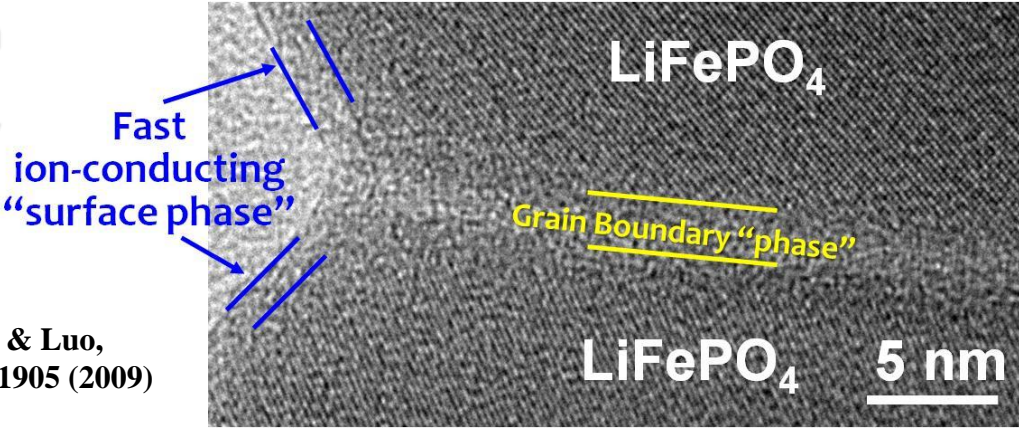
## Capabilities Relevant to These Programs

- Sintering of ceramics and metals; various high-*T* quench furnaces (controlled atmospheres)
- Materials characterization (TEM, HRTEM, STEM, diffraction, surface analysis, etc)
- High-*T* (up to 1500 °C) optical microscopy in controlled atmospheres; high-*T* wetting measurements
- Chemical adsorption and temperature-programmed desorption, reduction and reaction
- Some device testing capabilities; some modeling capabilities

Updated: June 2010

# New Projects Starting in 2010...

## Surface Adsorption and Disordering in Lithium-Ion Battery Materials

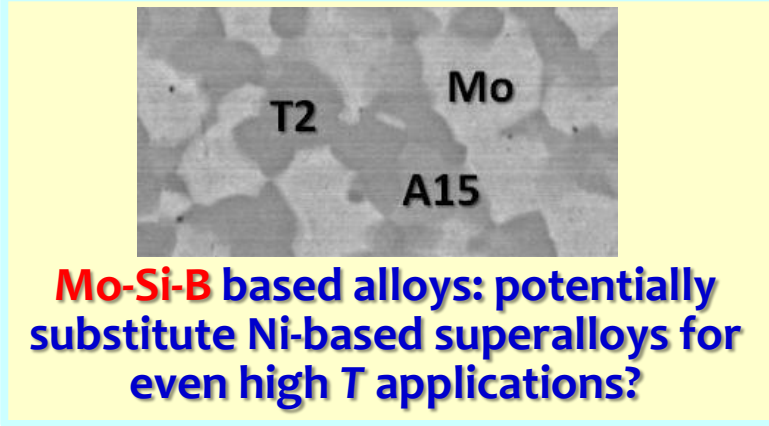


from Kayyar, Qian & Luo, *Appl. Phys. Lett.* 95: 211905 (2009)

Supported by National Science Foundation (2010-2014)



## Mo-Si-B: High-T Interfacial Thermodynamics for Mechanism-Informed Materials Design

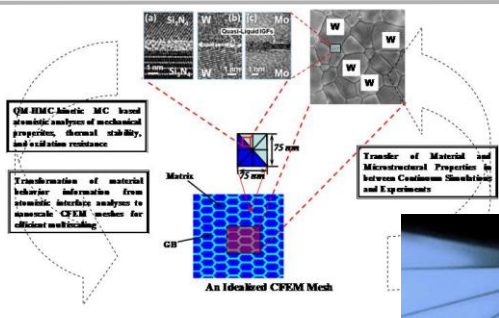


Supported by Air Force Office of Scientific Research (2010-2013)



## Multiscale Modeling of Grain Boundary Segregation and Embrittlement in Tungsten

In collaboration with Prof. Vikas Tomar, Purdue University



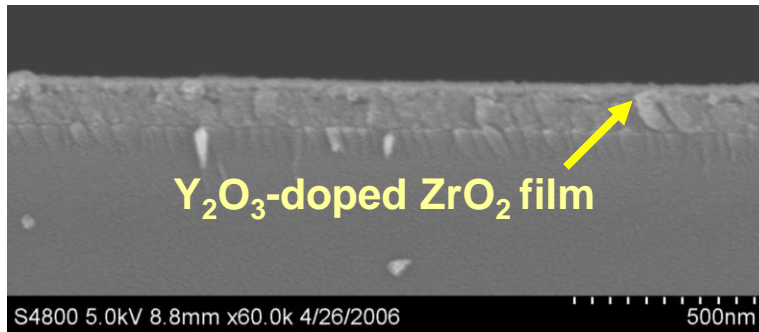
Supported by DOE National Energy Technology Laboratory University Coal Research Program (2010-2013)



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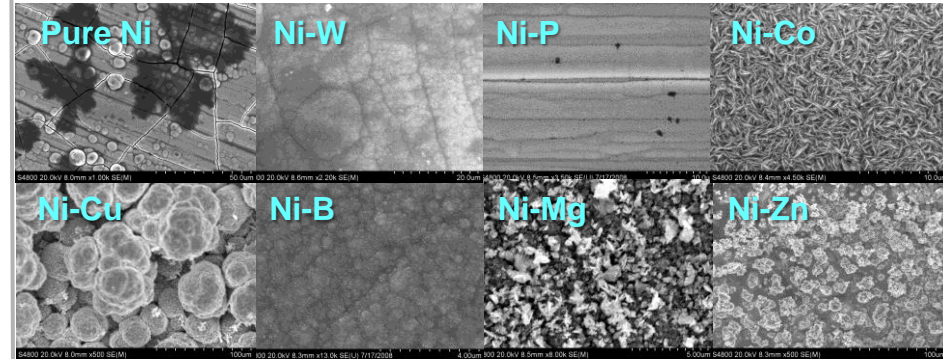
Updated: June 2010

## Solution-Based (Cost-Effective) Synthesis of Functional Oxide Films & Multilayers

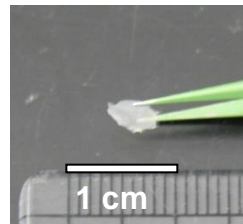
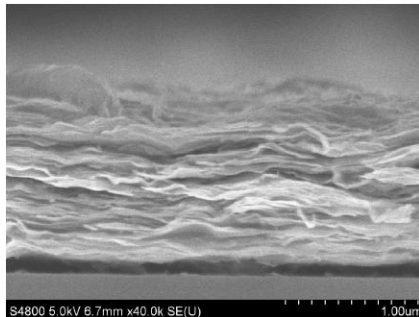
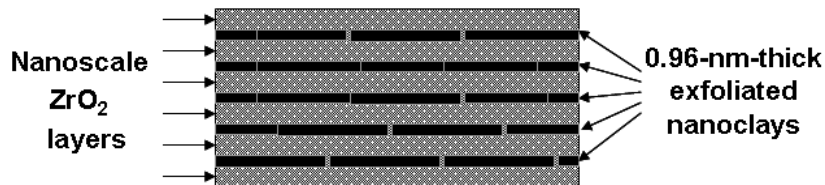


Selected Publication: Surf. Coat. Tech. 202:2690 (2008)

## Electrodeposition of Nanocrystalline Metal Films: Controlling morphology & microstructure via doping & grain boundary chemistry



## Synthesis of [Nanoclay-Oxide<sup>sol gel</sup>]<sub>n</sub> Multilayers via Layer-by-Layer Assembly



Free-standing films

Selected Publications: J. Mater. Chem. 20:4295 (2010);  
J. Nanomater. 2008: 749508; J. Mater. Res. 24:777 (2009)

In collaboration with Prof. Guoping Zhang, LSU

## Technological Relevance:

- Multi-functional & functionally-graded films
- Bio sensors (with Prof. Guigen Zhang, BioE)
- Biomimetic “artificial nacre” for high-*T* protective coatings
- MEMS components
- Interface-based fast oxygen ionic conductors for fuel cells and electrochemical sensors

## Capabilities Relevant to These Programs

- Fabrication of various ceramic & metal films and coatings
- Dip coating w/ 1-8 solutions & fine controls
- Spin coating
- Electrodeposition
- Materials characterization

Updated: June 2010