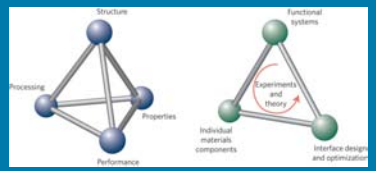
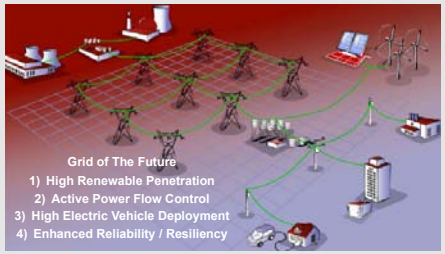


Grid-Related Materials Development Across the NETL-RUA: A Proposed Integrated Materials Development Initiative

NETL-RUA
Regional University Alliance

Needs for Advanced Materials in Grid Applications

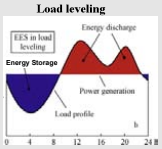


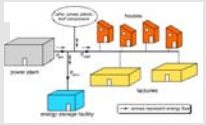
Relevant Material Classes

www.arpa-e.energy.gov

Active / Passive Components in Power Electronics

Grid-Scale Energy Storage

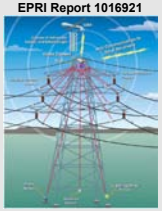




Grid energy storage

EPRI Report 1020619

EPRI Report 1016921



Sensors for Power Flow Control and Condition Monitoring

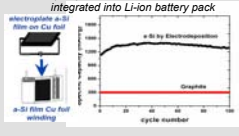
Office of Research & Development Activities

Enduring Expertise in Electrochemical Materials

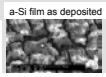
Energy Storage Materials

Research focusing on developing low cost processing methods to produce unique microstructures with enhanced performance characteristics.

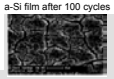
Electro-plating (patent pending) for amorphous silicon (a-Si) Film on Cu foils that can be easily integrated into Li-ion battery pack



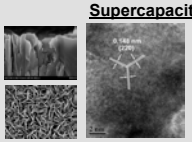
a-Si film as deposited

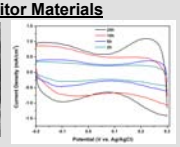


a-Si film after 100 cycles



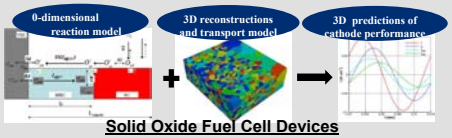
Supercapacitor Materials





Cyclic voltammograms of the NiO platelet nanoarrays indicates a promising electrode materials for supercapacitor.

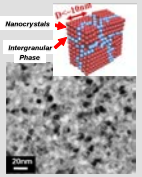
Materials Development with a Device Emphasis



Solid Oxide Fuel Cell Devices

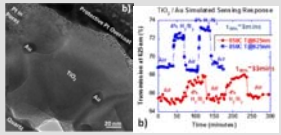
Modeling + Characterization → Optimal Device Performance

Magnetic Nanocomposites



Inductors and Sensors

Advanced Optical Materials



P. R. Ohodnicki et al. J. Appl. Phys. 111, 064320 (2012)

Emerging Expertise in Magnetic and Optical Materials

Relevant Centers and Expertise Within the Regional University Alliance

PENNSTATE

Battery & Energy Storage Technology Center (BEST) http://www.best.psu.edu/

Capacitor Materials:
Center for Dielectrics

Semiconductor Materials:
Penn-State Electrooptics Center

Carnegie Mellon University

Inductor / Sensor Materials:
McHenry

Semiconductor Materials:
Skowronski, Davis

Energy Storage Materials:
Whitacre

University of Pittsburgh
Center for Energy

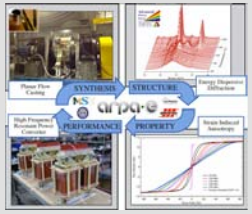
Energy Storage Materials:
Kumpta

VirginiaTech
Center for Power Electronic Systems
http://www.cpes.vt.edu/

WestVirginiaUniversity

Broad Overview of Relevant Partner Institution Capabilities

Inductor Material Expertise Example



Funded Arpa-E Project Led By Prof. Michael McHenry of CMU

Novel Alloy Development for High Frequency Transformers

Originated from NETL-Authored White Paper on High Frequency Transformers for Grid-Integration of Solid Oxide Fuel Cells

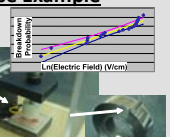
Strong Collaborative Interactions with Paul Ohodnicki of NETL

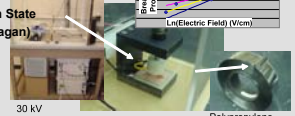
Capacitor Material Expertise Example

Center for Dielectrics at Penn State (Clive Randall / Michael Lanagan)

CDP NCSU PSU

Dielectric Breakdown Laboratory





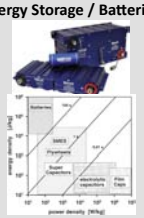
30 kV source

Dielectric spacer on top of bottom copper electrode

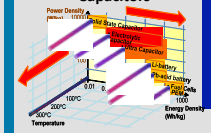
Polypropylene sample is placed on top of spacer

Forward Looking Vision: Integrated Development Initiative

Energy Storage / Batteries



Capacitors



Materials for Power Electronics and Power Flow Control Applications

Leverage NETL-RUA relationships with strategic NL and Industrial Partnerships

Develop innovative and practical materials/devices (semiconductors, capacitors, inductors, energy storage components and devices)

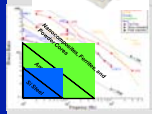
Accelerate the design and deployment of grid-technologies by applying multi-scale computational approaches, ranging from materials design through grid-scale optimization.

Establish Testing Capabilities at NETL for Key Performance Metrics for Integration of Advanced Materials in Components : Potentially Through SOFC Program

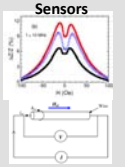
Leverage Control, Systems, and Circuit Design Expertise of NETL-RUA GTC to Design, Test, and Build Components and Test at Grid-Scale with Novel Materials

Fund an NETL-Led Seed Project in the Inductor / Current Sensor Materials Area

Inductors



Sensors



Proposed Integrated Material Development Initiative Coupling Material Development with Device Level Testing