NANOSTRUCTURES FOR ELECTRICAL ENERGY STORAGE
DOE ENERGY FRONTIER RESEARCH CENTER (EFRC-NEES)

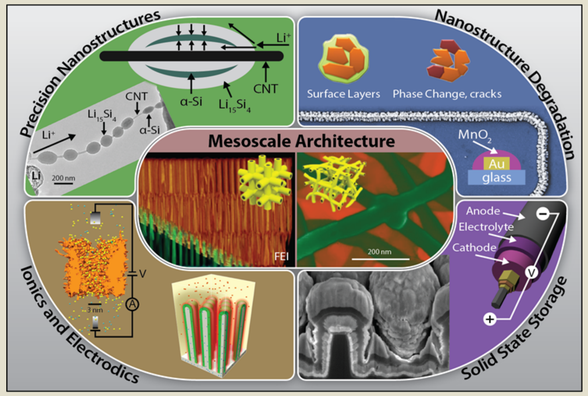
Gary Rubloff, Director Sang Bok Lee, Deputy Director Elizabeth Lathrop, Assoc. Dir. For Programs University of Maryland

30 THIRTY YEARS OF SYSTEMS RESEARCH EXCELLENCE

INSTITUTE FOR SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL OF ENGINEERING

STRUCTURES, DEVICES AND ARCHITECTURES FOR NANOSCALE SOLUTIONS IN ELECTRICAL ENERGY STORAGE

Mission: To reveal scientific insights and design principles that enable a next-generation electrical energy storage technology based on dense mesoscale architectures of multifunctional nanostructures. NEES (2009-2018)



Nano science and technology promise enhancement to batteries and capacitors through higher power at given energy, accompanied by new possibilities for better capacity retention and safety. Precision multistep synthesis has enabled the creation of **heterogeneous nanostructures**, involving multiple materials to confer the needed multifunctionality and to understand how design influences electrochemical behavior at the nanoscale and storage performance of nanostructures. Exemplary advances include: (1) Si nanowire and nanotube structures with integrated electron transport components that achieve robust Li cycling despite large volume changes; (2) nanopore battery configurations to assess **fundamental limits on electronic and ion transport in highly confined environments**; (3) **solid state electrolyte and battery configurations** for scaling safe materials to the nanoscale; and (4) 3D nanostructure forests, both regular and pseudo-random, to analyze **mesoscale architectures and new scientific challenges emerging at the mesoscale**.

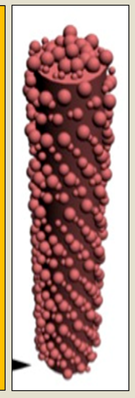
Major Thrust Advances

- Nanostructure Interface Science
- Mesoscale Architectures and Ionics
- Nanostructure Degradation Science
- Solid State Energy Storage

Mesostructure & Hierarchical Architectures

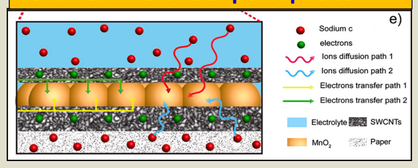
Nanostructured Batteries & Devices

Nanoflakes on MnO_2 Nanowires



Sang Bok Lee

Cellulose fibers as supercapacitor



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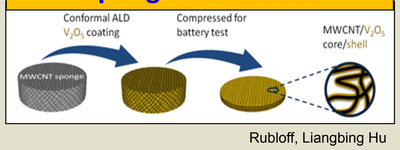
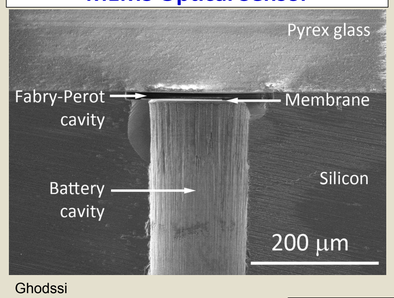
$MWCNT/V_2O_5$ core/shell sponge electrodes



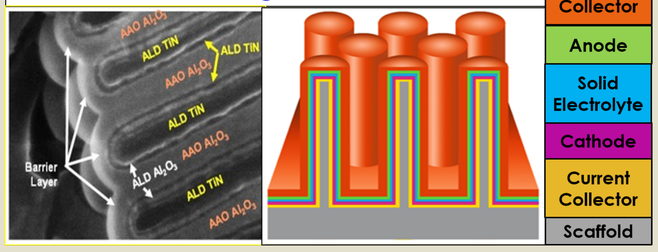
Rubloff, Liangbing Hu

MEMS Optical Sensor



Ghodssi

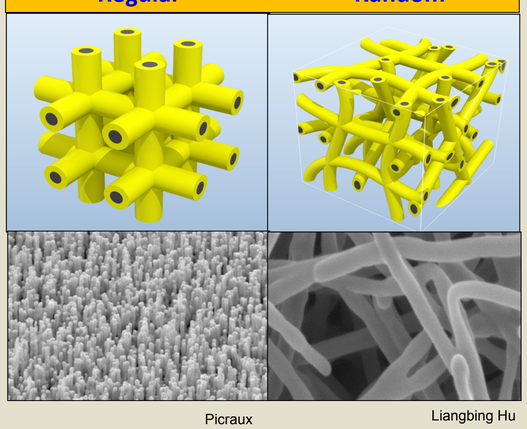
AAO-ALD for interdigitated nanostructures



Rubloff

Current Collector
Anode
Solid Electrolyte
Cathode
Current Collector
Scaffold

Regular Random

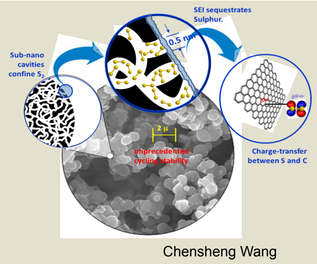


Picraux Liangbing Hu

Energy textile from weavable f-CNT@Si electrodes

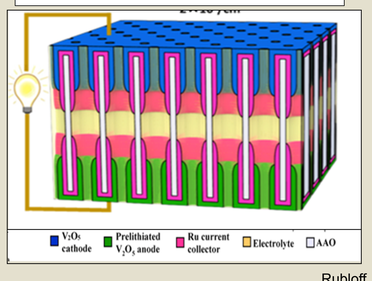
YuHuang Wang

Lithium Sulfide-Graphite Batteries

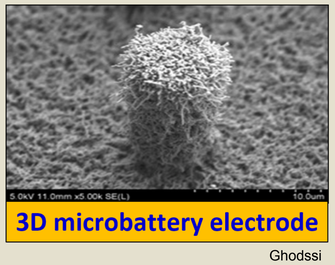


Chensheng Wang

Precision Nanobatteries



Rubloff



3D microbattery electrode

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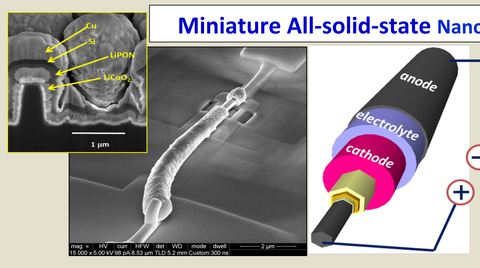
Miniature All-solid-state Nanobattery



Si
LiPON
$LiCoO_2$
Ti/Pt/Ti
Si

Cumings, Talin

NEES Team – lead institution: University of Maryland		
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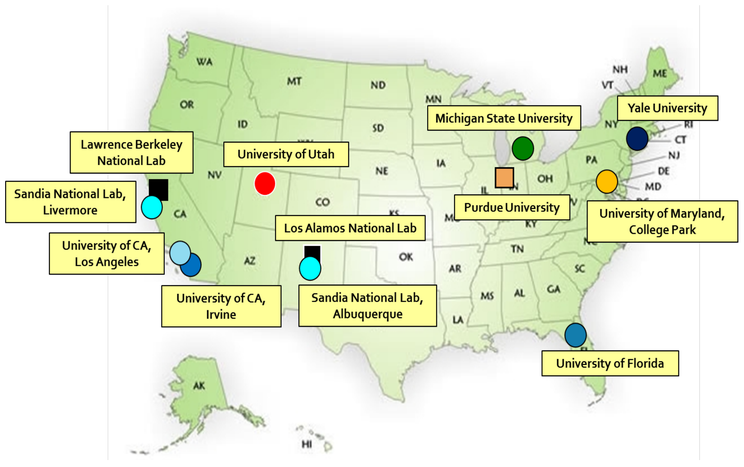

This work was supported as part of the Nanostructures for Electrical Energy Storage (NEES), an Energy Frontier Research Center (EFRC) funded by the U.S. Department of Energy, Office of Science.

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