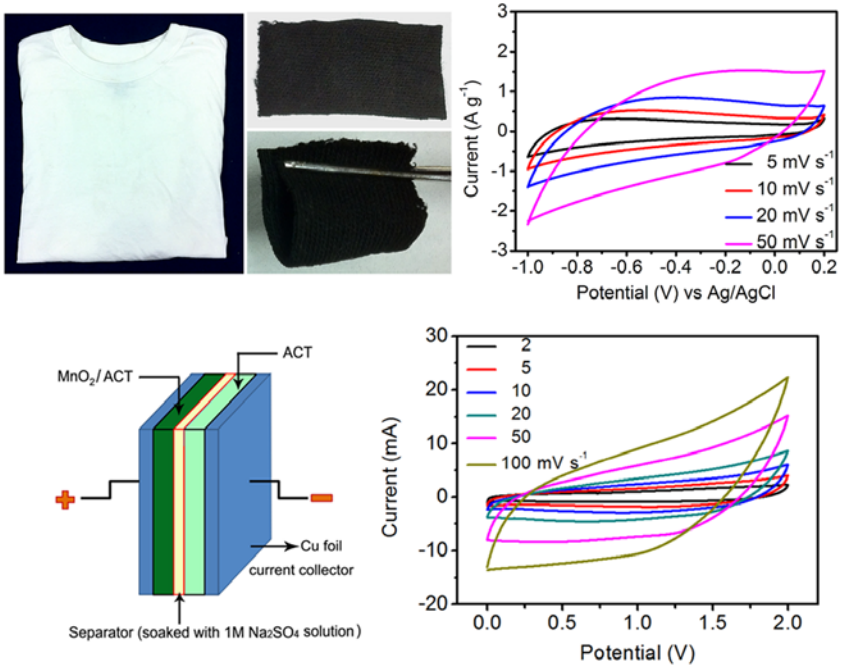

Lab for nano-enabled and bioinspired materials design, manufacturing and health monitoring focuses on nanomanufacturing, nanomaterial-enabled energy systems, surface engineering, biological and bio-inspired systems and devices, biomaterials, nano/biomechanics, and mechanics and tribology in nuclear and/or turbine energy systems. The laboratory has been heavily sponsored by the National Science Foundation (NSF), Army Research Office (ARO), NASA, DOE/National Laboratories, Petroleum Research Fund, Intel, GE Energy, GE-Hitachi Nuclear Energy, General Motors Cooperation, and Westinghouse. The breakthrough work has been featured by over 1,000 media outlets worldwide including BBC, Discovery News, Science Daily, MSNBC, and New York Times. The innovation on cotton textile based green manufacturing of composites was recently selected by New York Times Year in Ideas for Year 2010.

Lab for Nano-enabled & Bioinspired Materials Design, Manufacturing and Health Monitoring

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"Interdisciplinary research on nano-enabled and bioinspired materials design, manufacturing and health monitoring."

UNIVERSITY of VIRGINIA
ENGINEERING

Nanocomposites and flexible energy storage devices

The lab, for the first time, converted cotton textiles into light-weight, high-strength and energy-efficient material – B4C and flexible energy systems such as supercapacitors, revolutionizing the way how people manufacture composite structures and energy systems. The concept, using biomaterials as templates to realize green manufacturing, is indeed innovative. With two NSF grants and strong industry support, this group is moving on to extend natural material based green tech to flexible/stretchable electronic devices. The research has attracted much attention in the society. Discovery News and MSNBC reported the research and New York Times selected the concept as Year in Ideas for Year 2010.

Health-monitoring and self-healing techniques for manufacturing of nanodevices

The lab integrated the digital image correlation technique into the manufacturing systems for quality control and performance monitoring. The research activities have been highly funded by ARO, DOE/National labs, GM, and Intel. We proposed a new mechanism for tin whisker formation in electronic packaging, which is significant for developing lead free soldering process. The lab solved the most critical issue in the manufacturing of lithium-ion batteries, providing new design and fabrication guidelines for next generation batteries. The lab is working on a new manufacturing health monitoring tool for nanoelectronic devices.

Harsh environment mechanical testing

The lab has developed a new methodology for testing thermal barrier coating bonding strength. We study the friction and wear of turbine engines from the design and manufacturing points of view. We have extended to nuclear field by introducing surface engineering concept. The lab helped industry solve manufacturing problems.

Biomaterials and biomechanics

The lab has been working on seashells and bamboo. We proposed to learn materials design and manufacturing from Mother Nature. We recently introduced the nature-inspired design and manufacturing concepts to produce light-weight and energy-efficient materials for automobile and aerospace industries.

Nanocomposites

To take full advantages of the structural uniqueness and exceptional properties of graphene in composites, harvesting monolayer graphene is essential. On the other hand, it is challenging to achieve simultaneously high stiffness, strength and toughness in engineered materials because of the tradeoff relations between these properties. We demonstrate that the grapheme reinforcing potentials can be significantly enhanced through the excellent dispersion of monolayered graphene sheets in the matrix material and the strong graphene-matrix bonding by the coupled hydrogen passivation and ultrasonication technique. The fabricated graphene/epoxy composites exhibit simultaneously remarkable increase in elastic modulus, fracture strength and toughness. We found that the inlet hydrogen atoms in the hydrogen passivation serve as a source of the second atoms to terminate the C dangling bonds and form more stable C-H bonds, separating graphene flakes into monolayered sheets and promoting the binding with the matrix material.

RECENT RESEARCH DEVELOPMENTS

- Converted a cotton t-shirt into a body armor and flexible energy storage device.
- Discovered the secret recipe for bio-inspired ultra-light weigh nanocomposites.
  Developed a nanostructure health monitoring technique.
- Professional Engineering Publisher´s PE Prize (2008), University of South Carolina CEC Research Progress Award (2008) and CEC Research Achievement Award (2011).
- News coverage by BBC, Discovery News, Science Daily, MSNBC, and Nature China.

RECENT GRANTS

- NSF - High Throughput Manufacturing of Carbide Nanowire-Carbon Microfiber Hybrid Structures & Polymer Composites from Cotton Textiles
- NSF: Flexible Core/Shell Nanocable – Carbon Microfiber Hybrid Composite Electrodes for High-Performance Supercapacitors
- NSF: Synthesis of Necklace-Shaped Boron and Boride Nanowires for Polymer Nanocomposite Applications

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