



University of Pittsburgh

Energy Storage and Conversion – New Opportunities

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Prashant N. Kumta-Electrochemical Energy Storage and Conversion

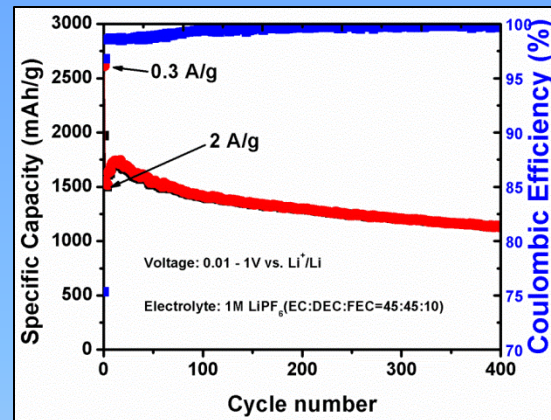
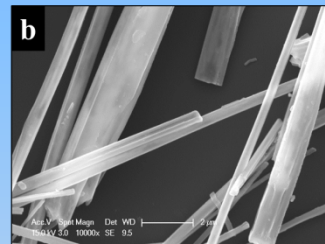
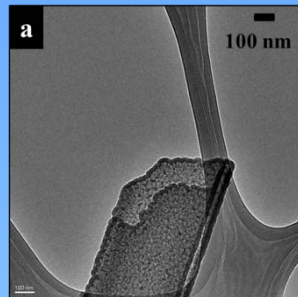
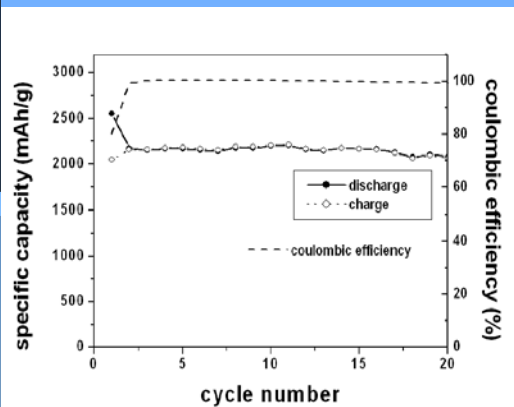
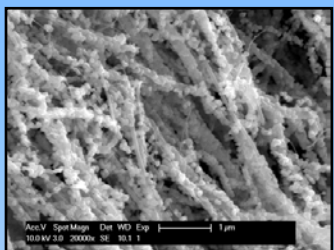
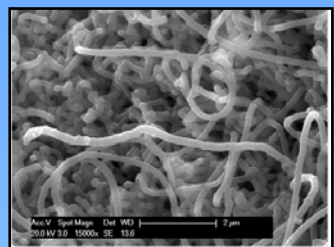


- Work in a variety of energy generation and storage areas
- Over 25 publications, 3 patent applications in energy storage since 2013
 - Work spans the diverse fields of
 - Lithium-ion batteries
 - Magnesium batteries
 - Sodium batteries
 - Fuel Cells
 - Water electrolysis
 - Photo-electrocatalysis
 - Supercapacitors
 - Lithium Sulfur batteries
- Editor in Chief of 'Materials Science & Engineering-B'-
An Elsevier Journal

DOE- BATT: Silicon as anode material for Lithium Ion Batteries

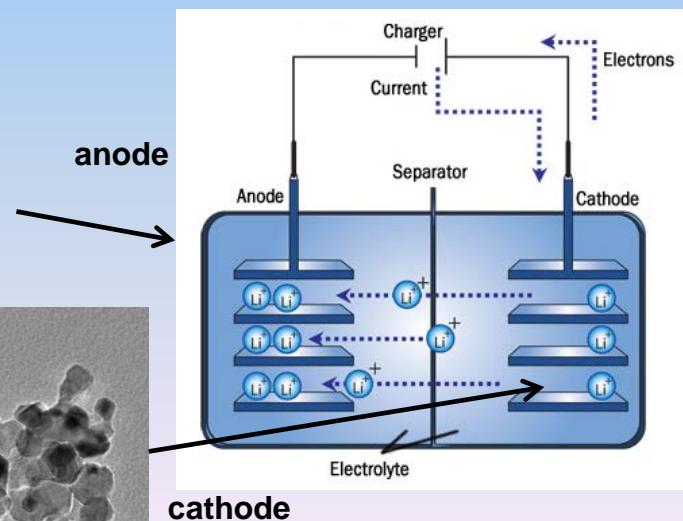
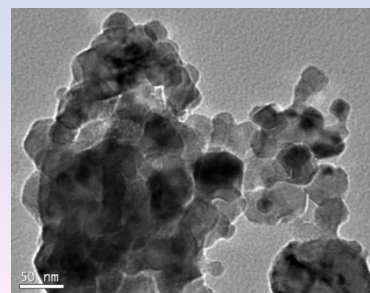
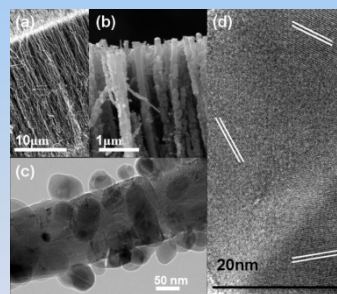
CNT – Si Heterostructures

Hollow Silicon Nanotubes

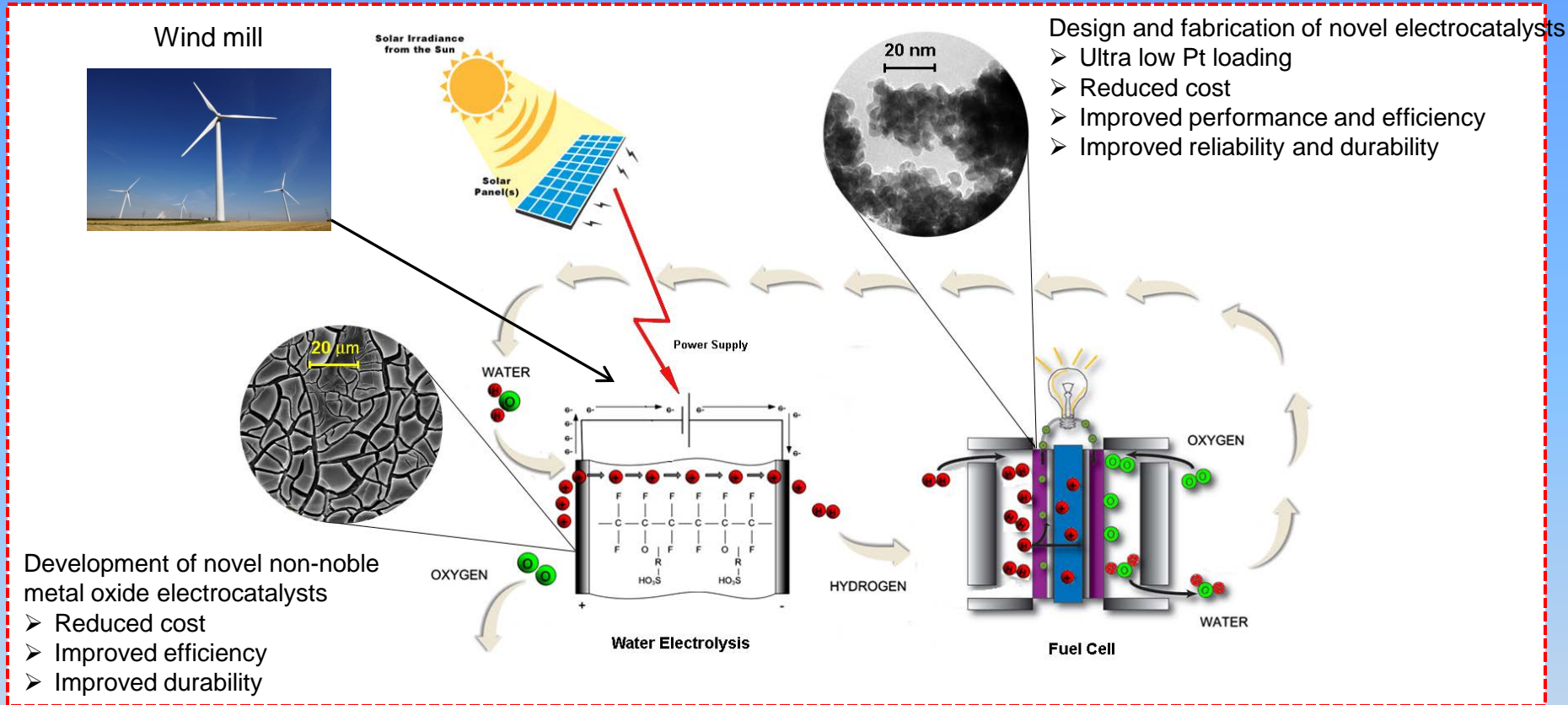


Completely recyclable template
High output

- Part of the \$2.7 million DOE-BATT program into Silicon anodes since 2007
- Over 20 publications, 1 patent application and over 15 conference presentation resulted from this work



Renewable Energy for Hydrogen Economy

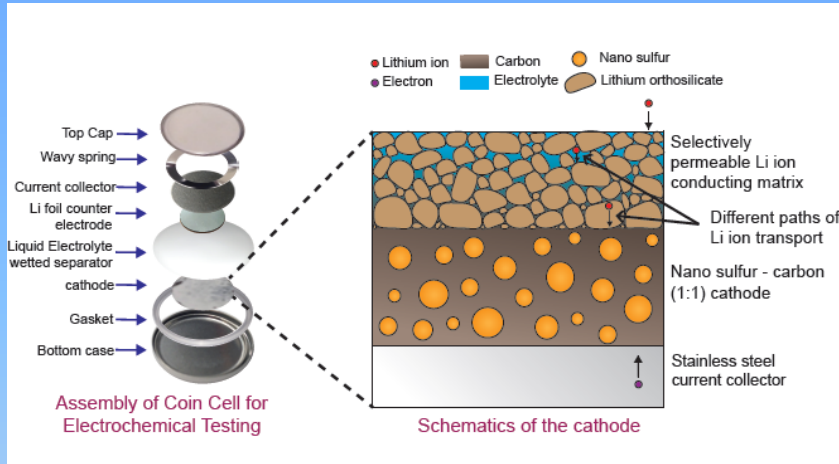


- Fundamental theoretical and experimental studies to develop electrically conducting and electrochemically stable non-noble metal based electro-catalysts and electro-catalyst supports for water electrolysis and fuel cells

- Completed a 3 year \$750k DOE-Basic Energy Science program
- 10 publications, 1 patent application and over 15 conference presentation resulted from this work

Lithium-Sulfur batteries

- Started a 3 year \$ 1.25 million project funded by the US-DOE-Office of Vehicle Technologies



Schematic of multilayer composite electrode used to improve battery energy density and cycling stability

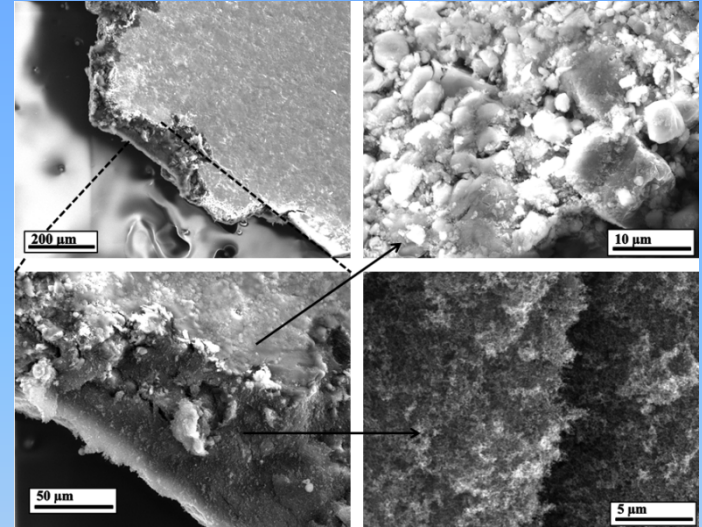
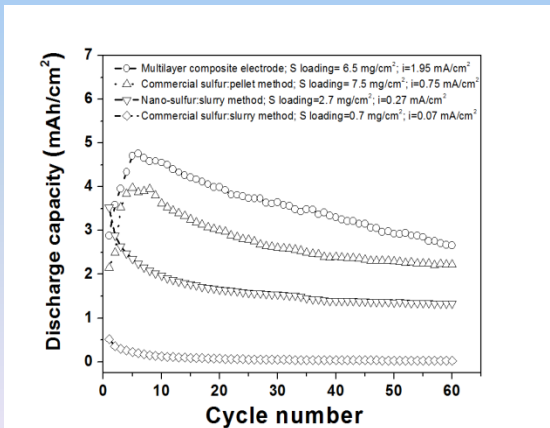
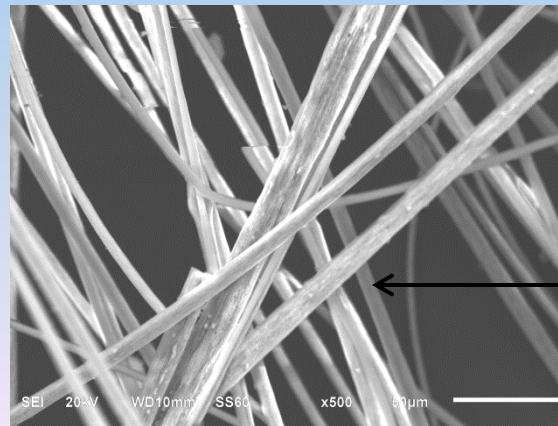


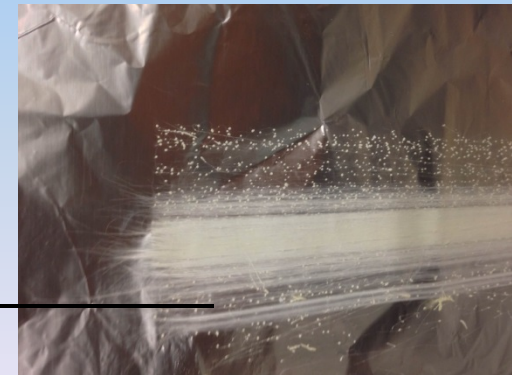
Image showing the ability to tailor lithium ion conducting thin coatings



Electrodes show three times as much capacity as current cathode materials. Will result in batteries lasting ~3 times longer than current systems



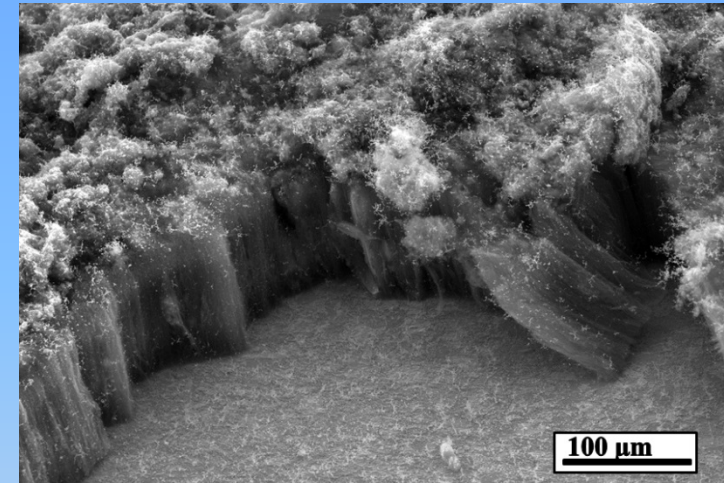
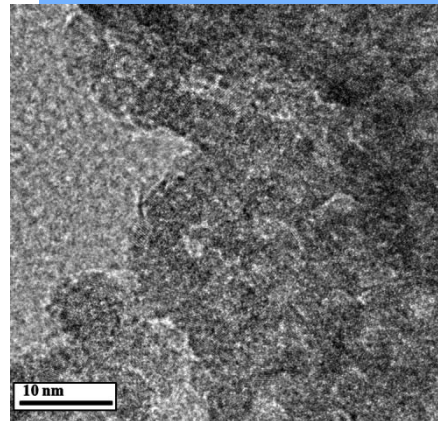
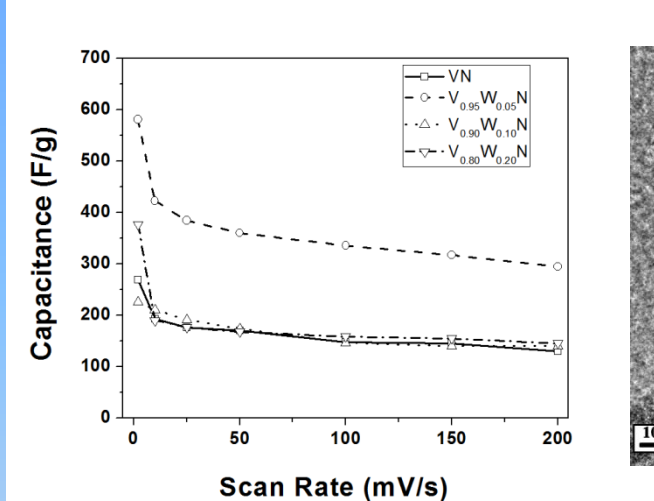
Novel high surface area fibers suitable for fabric batteries



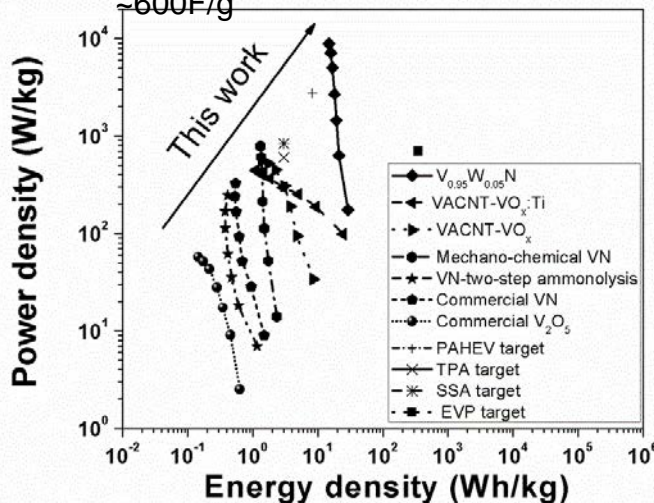
Jampani, P.H.; Gattu, B.; Velikokhatnyi, O.I.; Datta, M.K.; Damle, S.S.; Kumta, P.N. *Journal of the Electrochemical Society*, Vol. 161, pp. A1173-A1180 (2014)

Supercapacitors

- Pioneered research into nitride nanomaterials for supercapacitor applications
- US Patent 8,562,868, 2013-issued in 2013
- Partly funded by NSF, Arrowhead corporation, Edward R. Weidlein Chair funds



Doped nitride nanoparticles of ~4-5 nm demonstrate capacitances of ~600F/g



Ragone plot showing the superior energy densities of nitride nanomaterials and oxide-CNT electrodes

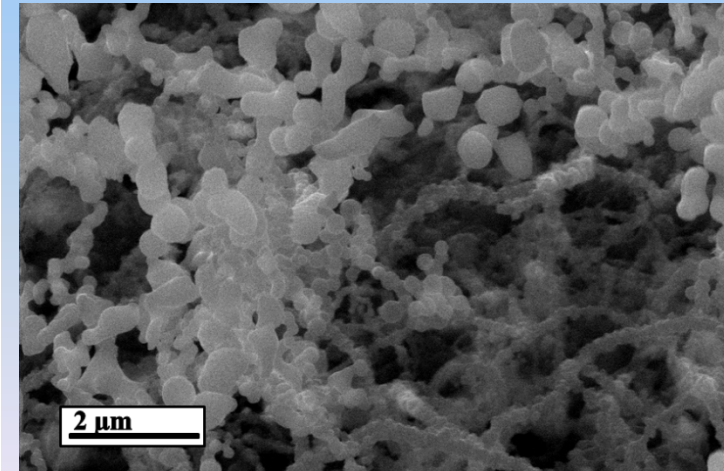


Image showing unique doped vanadium oxide coatings on vertically aligned carbon nanotube forest with very high energy density

Jampani, P.H.; Datta, M.K.; Kadakia, K.S.; Hong, D.H.; Chung, S.J.; Tam, M.C.; Poston, J.A.; Manivannan, A.; Kumta, P.N. *Journal of the Electrochemical Society*, Vol. 160, pp. A2195-A2206 (2013)

Prashanth, J.H; Kadakia, K.; Hong, D.H.; Epur, R.; Poston, J.A.; Manivannan, A.; Kumta, P.N., *Journal of the Electrochemical Society*, Vol. 160, pp. A1118-A1127 (2013)



Unique Opportunity

- Energy storage is a growing area
- Tremendous demand and opportunity
- Opportunity for local industry (PPG, Alcoa, II-VI)
- Opportunity for joint venture



IUPO - Concept

- **Explore non-conventional approach to industry-university interaction**
 - Incubator for direct translation of technology towards commercialization
 - Create a state-of-the-art manufacturing facility in partnership with industry
 - Industry and university faculty, student and staff participate in joint research activity with direct industrial relevance
 - Joint intellectual property that can be negotiated



Plans

- ~4,000 sq.ft. requested for creation of an Energy Storage Technology Laboratory (ESTL)
- Reach out to local and national industries to contribute to renovation of space and equipment infrastructure and facility
- In return, industry gets to use the facility for joint development of technology with use of industry and university personnel and staff
- ESTL: generate prototype batteries and energy storage test systems that can be fabricated and tested under practical end use operation conditions for automotive, laptop, digital camera, camcorders, and other consumer applications.