Clemson University Research Foundation

Polymer-Nanocarbon Composites for Energy Storage Applications (2013-025)

Energy storage electrodes efficiently store energy in both stationary and transportation settings

Market Overview

This composite material decreases energy storage costs compared to current commercially available technologies. The ability to store intermittent energy from sources such as wind and solar power is a major limitation for the commercial deployment of renewable energies in the consumer market. Currently used materials are not suitable for large-format energy storage due to either cost or safety concerns. However, large-scale energy storage is a rapidly growing market; the United States market saw a nine-fold increase between Q1 2016 and Q1 2017 in terms of deployed megawatt-hours of energy storage, and predicted to be a market size of $3.2 billion in the U.S. and $19 billion globally by 2022. Clemson University researchers have developed a material that overcomes current challenges in order to decrease energy storage costs for a variety of applications.

Application

Energy Storage - Stationary and Transportation

Stage of Development

Validated Prototype

Advantages

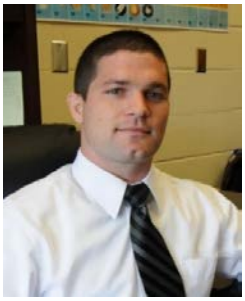
- Possesses high performance vs. weight ratio, making it more efficient than currently available methods
- Polymeric materials used are relatively inexpensive, decreasing the cost of storing energy and facilitating commercialization

Technical Summary

This invention integrates redox polymers such as lignin with carbon nanomaterials in a manner that exploits the high-energy capacity of non-conductive, but redox-active polymers. These polymers are incorporated either during electrode synthesis or through adsorption. The carbon nanomaterial provides conductivity and surface area, and the polymer enhances energy storage capability. Free-standing electrodes were developed using nanotubes and other forms of carbon nanomaterials to produce mechanically and chemically robust electrodes. Importantly, the polymeric materials used in this technology are abundant and renewable, making the fabrication process cost-effective. Based on the electrode performance, it is expected that the cost per energy storage unit can be reduced to $0.01-0.02/Whr ($0.17/Whr for standard lead-acid batteries). This composite also demonstrates a high-performance-to-weight ratio of 1500 W/kg.

App Type	Country	Serial No.	Patent No.	CURF Ref. Number	Inventors
Utility	United States	14/331,264	9,552,929	2013-025	Dr. Mark Roberts, Dr. Ramakrishna Podila, Dr. Apparao Rao, Robert Emmett

About the Inventors



Dr. Mark Roberts is an Associate Professor of Chemical & Biomolecular Engineering at Clemson University. Prior to joining Clemson, Dr. Roberts worked as process engineer at Semitool, Inc. and was a postdoctoral fellow at Sandia National Laboratory. He has 9 patents and has work published in a variety of academic journals. His research interests include developing polymeric materials and nanostructures for electronic systems, energy storage devices, and sensors.

Dr. Ramakrishna Podila is an Assistant Professor in the Department of Physics and Astronomy at Clemson University. He received his M.S. in physics from the Indian Institute of Technology at Roorkee in 2007 and a Ph.D. in Physics from Clemson in 2011. He worked as a post-doctoral fellow at the Brody School of Medicine in Greenville, NC until 2014. His current research is focused on elucidating fundamental optical, electronic, and magnetic properties of nanomaterials and using them for nanomedicine and energy applications.

Dr. Apparao Rao is the Robert A. Bowen Professor of Physics at Clemson University and Director of the Clemson Nanomaterials Institute. Prior to joining Clemson, Dr. Rao was a postdoctoral research assistant at MIT and a research assistant professor at the University of Kentucky. Dr. Rao is a fellow of the American Physical Society and the American Association for the Advancement of Science. He is a recipient of the SC Governor's Award for excellence in scientific research. His research interests include the synthesis, characterization and application of nanomaterials.

For More Information

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