PHYS.ORG

The hidden behavior of supercapacitor materials

November 9 2021

Credit: flickr/Wikimedia Commons, CC BY 2.0

Researchers from the University of Surrey's Advanced Technology

Institute (ATI) and the University of São Paulo have developed a new analysis technique that will help scientists improve renewable energy storage by making better supercapacitors.

The team's new approach enables researchers to investigate the complex inter-connected behavior of supercapacitor electrodes made from layers of different materials.

Improvements in energy storage are vital if countries are to deliver carbon reduction targets. The inherent unpredictability of energy from solar and wind means effective storage is required to ensure consistency in supply, and supercapacitors are seen as an important part of the solution.

Supercapacitors could also be the answer to charging electric vehicles much faster than is possible using lithium-ion batteries. However, more supercapacitor development is needed to enable them to effectively store enough electricity.

Surrey's peer-reviewed paper, published in *Electrochimica Acta,* explains how the research team used a cheap polymer material called Polyaniline (PANI), which stores energy through a mechanism known as pseudocapacitance. PANI is conductive and can be used as the electrode in a supercapacitor device, storing charge by trapping ions. To maximize energy storage, the researchers have developed a novel method of depositing a thin layer of PANI onto a forest of conductive carbon nanotubes. This composite material makes an excellent supercapacitive electrode, but the fact that it is made up of different materials makes it difficult to separate and fully understand the complex processes which occur during charging and discharging. This is a problem across the field of pseudocapacitor development.

To tackle this problem, the researchers adopted a technique known as the Distribution of Relaxation Times. This analysis method allows scientists to examine complex electrode processes to separate and identify them, making it possible to optimize fabrication methods to maximize useful reactions and reduce reactions that damage the electrode. The technique can also be applied to researchers using different materials in supercapacitor and pseudocapacitor development.

Ash Stott, a postgraduate research student at the University of Surrey who was the lead scientist on the project, said: "The future of global energy use will depend on consumers and industry generating, storing and using energy more efficiently, and supercapacitors will be one of the leading technologies for intermittent storage, energy harvesting and high-power delivery. Our work will help make that happen more effectively."

Professor Ravi Silva, Director of the ATI and principal author, said: "Following on from world leaders pledging their support for green energy at COP26, our work shows researchers how to accelerate the development of high-performance materials for use as energy storage elements, a key component of solar or wind energy systems. This research brings us one step closer to a clean, cost-effective energy future."

More information: Ash Stott et al, Exploring the underlying kinetics of electrodeposited PANI-CNT composite using distribution of relaxation times, *Electrochimica Acta* (2021). DOI: 10.1016/j.electacta.2021.139501

Provided by University of Surrey