Oxygen Functionalized Carbons for Rechargeable Lithium Batteries
Technology #15063

Applications

Functionalized multiwalled carbon nanotubes (MWNTs) can be used as electrodes in lithium batteries.

Problem Addressed

Batteries exhibit high energy as a result of faradaic reactions in the bulk of active particles, but are rate-limited. The alternative, electrochemical capacitors, can deliver high power but at the cost of low energy storage, by making use of surface ion adsorption (referred to as double-layer capacitance) and surface redox reactions (referred to as pseudo-capacitance). A promising approach to merging the advantages of these two different technologies is the use of nanostructured carbon electrodes. Nanostructured carbon electrodes use the faradaic reaction of the surface functional groups to store more energy than the double-layer capacitance on conventional capacitor electrodes and also provide high power capability.

Technology

Sub-millimeter long few-walled carbon nanotubes (FWNTs) minimize the number of junctions, which can enhance electrical conductivity and the mechanical strength in self-standing networks. In the case of multi-walled carbon nanotube-graphene electrodes, multi-walled carbon nanotubes (MWNTs) can allow successful utilization of the high surface areas of graphene by serving as a “pillar” inserted between graphene sheets that helps reduce the extent of agglomeration, creating a novel ordered, hierarchical structure with electrochemically accessible surfaces. Oxygen functional groups of carbons have Faradaic reactions with lithium ions in lithium cells, therefore, the energy density of carbon electrodes can be controlled by the oxidation time. Functionalized MWNTs that include pseudo-capacitive functional groups are assembled using the layer-by-layer (LBL) technique. These additive-free LBL-MWNT electrodes exhibit high gravimetric energy (200 W h kg\(^{-1}\)) delivered at an exceptionally high power of 100 kW kg\(^{-1}\) in Li/LBL-MWNT cells when normalized to the single-electrode weight, with no loss observed after completing thousands of cycles.

Advantages

- Increases gravimetric energy
- Increases power delivery
- Increases cyclability

Categories For This Invention:

Energy
Energy Storage
Batteries
Lithium Batteries

Intellectual Property:

Carbon Electrodes
Issued US Patent
9,070,932

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Publications:

High-Power lithium Batteries from Functionalized Carbon-Nanotube Electrodes
Nature
June 20, 2010

External Links:

Electrochemical Energy Lab
http://web.mit.edu/eel/index.html
Hammond Lab
https://hammondlab.mit.edu/

Image Gallery: