Hybrid Energy Storage

Supercattery

Electron Microscopy Images

Hybrid energy storage devices (hybrid of supercapacitor and battery) can be charged and discharged within seconds like a conventional capacitor and also have a high energy density like a battery. These are two electrode electrochemical cells which should have good electrical conductivity and capability to store huge amount of charges with long term stability. Electrode material along with the electrolyte determines the charge storage characteristics of a hybrid energy storage device.

Advanced Energy Materials Team is working on developing novel nano-heterostructured electrode materials to be used in the next generation hybrid energy storage systems. Different substrates (metallic and carbon based) were investigated to fabricate the electrode due to their good conductivity and unique structure.

Three dimensional hierarchical NiO nanostructures with combined microstructure of nanoflakes and nanoflowers, Coaxial NiO/Ni nanowire, Co3O4 nanowire, α-CoMoO4 nanoflakes, NiO-In2O3 heterostructure and Ni3(PO4)2·8H2O nano/microflakes have been developed. The Co3(PO4)2·8H2O electrode exhibits a high specific capacitance of 1578 F g⁻¹ (6.3 F cm⁻²) at 5 mA cm⁻², and the Co3(PO4)2·8H2O//activated carbon hybrid device delivered a good energy density of 29.29 Wh kg⁻¹ (1.17 mWh cm⁻³). The NiO-In2O3/NF based symmetric supercapacitor exhibits a remarkable cycle stability of 79% after 50,000 cycles. Furthermore, the team is aspire to increase the energy density beyond 100 Wh kg⁻¹ and enhance the cycling stability towards 100,000 cycles for these hybrid energy storage devices.

Photograph of the Packaged Supercapacitor

The flexible substrate-supported nanomaterials based packaged hybrid energy storage device was assembled in our lab. We also design different packages for various electrode materials and electrolytes to develop complete energy storage device.
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Related Publications

Hierarchical NiO-In2O3 microflower (3D)/nanorod (1D) hetero-architecture as a supercapattery electrode with excellent cyclic stability.
Authors: N. Padmanathan, Han Shao, David McNulty, Colm O'Dwyer, Kafil M. Razeeb

Pseudocapacitance of α-CoMoO4 nanoflakes in non-aqueous electrolyte and its bi-functional electro catalytic activity for methanol oxidation.
Authors: N. Padmanathan, Han Shao, S. Selladurai, Colm Glynn, Colm O'Dwyer, Kafil M. Razeeb

Ultra-fast rate capability of a symmetric supercapacitor with a hierarchical Co3O4 nanowire/nanoflower hybrid structure in non-aqueous electrolyte.
RSC Advances volume 5 issue 17 pages 12700 to 12709 (2015)
Authors: N. Padmanathan, S. Selladurai, Kafil M. Razeeb

Coaxial NiO-Ni nanowire arrays for high performance pseudocapacitor applications.
Electrochimica Acta volume 60 pages 193 to 200 (2012)
Authors: Maksudul Hasan, Mamun Jamal, Kafil M. Razeeb