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Ultrahigh-Performance Hybrid Supercapacitors from Stem-Like Carbon Networks & Flower-Like MoS_2 Structures

Morphology-engineered electrodes achieve >80 Wh/kg energy density with ultra-fast cycling for EVs and storage.

Researchers at Purdue University have developed a technology based on an innovative supercapacitor electrode, composed of carbon nanotubes (CNT), zeolitic imidazolate framework (ZIF), and flower-like molybdenum disulfide (fMoS2). This unique morphology results in an ultrahigh energy density of over 80 Wh/kg and exhibits impressive long-term cyclic stability, retaining near perfect Coulomb efficiency over 10,000 cycles. With the unprecedented power and energy density, this novel electrode shows great promise for a variety of applications that demand rapid charging and discharging of substantial amounts of energy.

The performance of this electrode is attributed to its distinctive morphology, which enhances energy storage by increasing surface area and exposing more edge sites, leading to efficient charge transport. Moreover, the composite demonstrates a high contribution of Faradaic pseudocapacitance (FPC)-controlled processes, which play a pivotal role in achieving the high energy density. This supercapacitor's high energy density, swift charging capabilities, and enduring cyclic stability render it suitable for a diverse range of applications, such as electric vehicles and renewable energy storage systems.

Technology Validation:

- Ragone plot shows that the energy and power densities of the CNT-ZIF-fMoS2 electrode surpass those of other energy devices

- The electrode achieves an energy density of ~80 Wh/kg and a power density of ~3000 W/kg, making it competitive with lithium-ion batteries.

Advantages:

Technology ID
2022-CHOI-69897

Category
Energy & Power Systems/Energy Storage
Materials Science & Nanotechnology/Nanomaterials & Nanostructures
Materials Science & Nanotechnology/Composites & Hybrid Materials

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- Exceptional energy density and cyclic stability

- Rapid charge and discharge capabilities

Applications:

- Application in Electric vehicles (EVs) due to the fast charging and discharging capabilities that allow for improved range and reduced charging time

- Potential for use as an alternative form of renewable energy storage

- Power backup systems

- Portable electronics

Publication: https://doi.org/10.1021/acsomega.3c00445

TRL: 2

Intellectual Property:

Provisional-Gov. Funding, 2023-03-04, United States

Utility-Gov. Funding, 2024-03-04, United States

Keywords: Capacitors, Chemical Engineering, Electrodes, Green Technology, Materials and Manufacturing