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Titanium Nitride @ Nitrogen-doped Carbon Nanocage as High-performance Cathodes for Aqueous Zn-ion Hybrid Supercapacitors

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Abstract : Aqueous Zn-ion hybrid supercapacitors (AZHSCs) pertain to a new type of electrochemical energy storage device that has received considerable attention. They integrate the advantages of high-energy Zn-ion batteries and high-power supercapacitors to meet the demand for low-cost, long-term durability, and high safety. Nevertheless, the challenge caused by the finite ion adsorption/desorption capacity of carbon electrodes gravely limits their energy densities. This work describes titanium nitride@nitrogen-doped carbon nanocage (TiN@NCNC) composite cathodes for AZHSCs to achieve a greatly improved energy density, and the composites can be facile synthesized based on the calcination of a mixture of tetrabutyl titanate and zeolitic imidazolate framework-8 in argon atmosphere. The resulting composites are featured by the ultra-fine TiN particles dispersed uniformly on the NCNC surfaces, enhancing the Zn2+ storage capabilities. Using TiN@NCNC cathodes, the AZHSCs can operate stably with a high energy density of 154 Wh kg-¹ at a specific power of 270 W kg-¹ and achieve a remarkable capacity retention of 88.9% after 104 cycles at 5 A g-¹. At an extreme specific power of 8.7 kW kg-1, the AZHSCs can retain an energy density of 97.2 Wh kg-1. With these results, we stress that the TiN@NCNC cathodes render high-performance AZHSCs, and the facile one-pot method can easily be scaled up, which enables AZHSCs a new energy-storage component for managing intermitted renewable energy sources.

Keywords : Zn-ion hybrid supercapacitors, ion absorption/desorption reactions, titanium nitride, zeolitic imidazolate framework-8
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