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High-performance supercapacitors based on S-doped polyaniline nanotubes decorated with Ni(OH)2 nanosponge and onion-like carbons derived from used car tyres

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Abstract

High performance supercapacitors are designed based on hierarchical Ni(OH)2 nanosponges anchored on sulfur-enriched polyaniline (PANI) nanotubes and waste tyre-derived onion-like carbons (OLC) as counter electrode materials. The rational strategy of grafting mesoporous thin sheets of Ni(OH)2 on PANI produces unique composite nanoarchitectures that shows superior potential in supercapacitors validated by higher electrochemical stability. The designed asymmetric supercapacitor configuration with OLC as anode exhibits excellent specific capacitance of 622 F g-1 at higher current density of 2 A g-1 with an exceptional capacity retention greater than 97% achieved upon 10,000 continuous charge-discharge cycles. The asymmetric device delivers the remarkable energy and power density of 70 Wh kg-1 and 136 kW kg-1, respectively, whereas the symmetric device delivers the maximum energy density of 23 Wh kg-1 and power density of 292 kW kg-1. Further, it is demonstrated that Ni(OH)2@PANI composite-based all solid-state flexible asymmetric supercapacitor construction with OLC exhibits high specific capacitance value of 166 F g-1 at a higher current density of 5 A g-1. The prolonged cycle stability may be attributed to the synergistic effect of 3D-nanosponge-like Ni(OH)2 on PANI nanotubes surface, stabilizing the volume changes upon cycling. The OLC derived from the pyrolysis of waste-tyres offers high energy density and better rate capability.