Nano-RuO_2-Decorated Holey Graphene Composite Fibers for Micro-Supercapacitors with Ultrahigh Energy Density

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Compactness and versatility of fiber-based micro-supercapacitors (FMSCs) make them promising for emerging wearable electronic devices as energy storage solutions. But, increasing the energy storage capacity of microscale fiber electrodes, while retaining their high power density, remains a significant challenge. Here, this issue is addressed by incorporating ultrahigh mass loading of ruthenium oxide (RuO_2) nanoparticles (up to 42.5 wt%) uniformly on nanocarbon-based microfibers composed largely of holey reduced graphene oxide (HrGO) with a lower amount of single-walled carbon nanotubes as nanospacers. This facile approach involes (1) space-confined hydrothermal assembly of highly porous but 3D interconnected carbon structure, (2) impregnating wet carbon structures with aqueous Ru^{3+} ions, and (3) anchoring RuO_2 nanoparticles on HrGO surfaces. Solid-state FMSCs assembled using those fibers demonstrate a specific volumetric capacitance of 199 F cm^{-3} at 2 mV s^{-1}. Fabricated FMSCs also deliver an ultrahigh energy density of 27.3 mWh cm^{-3}, the highest among those reported for FMSCs to date. Furthermore, integrating 20 pieces of FMSCs with two commercial flexible solar cells as a self-powering energy system, a light-emitting diode panel can be lit up stably. The current work highlights the excellent potential of nano-RuO_2-decorated HrGO composite fibers for constructing micro-supercapacitors with high energy density for wearable electronic devices.