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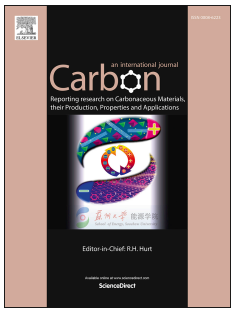

3D superelastic graphene aerogel-nanosheet hybrid hierarchical nanostructure as high-performance supercapacitor electrode

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Graphical Abstract

A three-dimensional graphene-based nanostructure with graphene aerogel templating graphene nanosheets (GA-GNs) has been fabricated via a modified hydrothermal method, followed by a microwave plasma chemical vapor deposition process. The mechanical properties of such hybrid nanostructures, for the first time, were quantitatively measured to demonstrate their superior mechanical robustness with stress and Young's modulus up to 96 kPa and 181.25 kPa, respectively. Finite-element modeling further reveals the mechanical strengthening mechanism with GNs as stiffening ribs layered over thin cellular walls within the GA. Moreover, GA-GNs present excellent electrical conductivity as high as ~1000 S/m, showing great promise as high-performance supercapacitor electrodes. The as-prepared free-standing and binder-free GA-GN electrode exhibits a high specific capacitance of 245 F g^{-1} (based on the entire electrode mass) which corresponds to a high areal capacitance of 1.1 F cm^{-2}, desirable rate capability and outstanding cyclic stability with a capacitance retention of 92% over 10000 cycles. To assess their practical functionality, a two-terminal symmetric all-solid-state supercapacitor based on such all-carbon electrodes was fabricated. Such supercapacitor devices exhibited desirable areal capacitance, low internal resistance and outstanding cyclic stability.