SUPERCAPACITORS

Edgeless graphene elevates voltage

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As with batteries, supercapacitors can be used in electric automobiles, especially when a high power delivery or uptake is required. However, supercapacitors are intrinsically inferior to batteries for energy-intensive applications. An important family of supercapacitors is those composed of carbon-based materials, as they can offer high power output and long lifespan. Most research efforts on carbon-based supercapacitors have been geared towards increasing their capacitance and consequently their energy density by using additional redox-active electrode materials or by replacing their organic electrolytes with unconventional ones, whereas relatively little progress has been made on improving the working voltage. Hirotomo Nishihara and colleagues from Tohoku University and TOC Capacitor Co. Ltd have now developed a three-dimensional framework of graphene mesosponges (GMS) that enables high-voltage operation of supercapacitors with conventional organic electrolytes and achieves 2.7-times-higher energy density than conventional carbon-based devices.

Building on their previous fabrication of GMS powder, the researchers adapted a compression-moulding technique to construct a continuous sheet of commercial Al_2O_3 nanoparticles, and then used chemical vapour deposition to coat it with a very thin carbon layer (approximately single layer). After annealing at a high temperature, discrete graphene grains are joined together with negligible edge sites left, forming a seamless graphene-like sheet structure. This structure does not suffer from the usual problems of defective and stacked graphene often found in activated carbons or reduced graphene oxides. Using the GMS sheets as supercapacitor electrodes, high electrochemical stability is shown at 4.4 V, compared with the typical working voltage of 2.8 V for supercapacitors using activated carbons. Furthermore, the mesopores inside the GMS, derived from the interparticle spaces of the compressed Al_2O_3 nanoparticles, also ensure a high surface area, which facilitates efficient charge storage.

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