High Volumetric Performance Aligned Nano-Porous Graphene-based Electrochemical Capacitors

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Abstract

The importance of electrochemical double layer capacitors (EDLCs) for energy storage has dramatically expanded the research in this area. Although very large gravimetric capacitances, as high as 200 F/g, has been reported for EDLCs, the volumetric properties as a more useful and practical metric has been overlooked. We prepared very high density (1.15 g/cm^3) aligned nanoporous graphene networks (A-NPG) by vacuum assisted self-assembly method which were utilized as the electrodes for EDLCs. Electrochemical analysis demonstrated very large volumetric capacitance of 197 F/cm^3 for A-NPG electrode using 1-ethyl-3-methyl-imidazolium bis (trifluoromethylsulfonyl) imide (EMIM TFSI) as electrolyte, when measured at 1 A/g discharge rate and 3.5 V maximum voltage. This value is about 4 times higher than the reported values for similar electrodes with lower bulk densities. This is attributed to the highly dense and well-ordered structure of A-NPG sheets which provides efficient packing of the sheets while preserving the concentration and distribution of nano-sized pores; known to be responsible for charge storage. Additionally, the supercapacitors exhibited very high volumetric energy and power densities which demonstrate the superior performance of graphene based supercapacitors and enable this new class of electrodes to be considered for practical energy storage applications such as portable devices, transportation and power management.