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Graphene-based lithium ion capacitor with high gravimetric energy and power densities

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Abstract

Hybrid capacitor configurations are now of increasing interest to overcome the current energy limitations of supercapacitors. In this work, we report a lithium ion capacitor (LIC) entirely based on graphene. On the one hand, the negative –battery-type- electrode consists of a self-standing, binder-free 3D macroporous foam formed by reduced graphene oxide and decorated with tin oxide nanoparticles (SnO_2-rGO). On the other hand, the positive –capacitor-type- electrode is based on a thermally expanded and physically activated reduced graphene oxide (a-TEGO). For comparison purposes, a symmetric electrical double layer capacitor (EDLC) using the same activated graphene in 1.5 M Et_4NBF_4/ACN electrolyte is also assembled. Built in 1 M $LiPF_6$ EC:DMC, the graphene-based LIC shows an outstanding, 10-fold increase in energy density with respect to its EDLC counterpart at low discharge rates (up to 200 Wh kg^{-1}). Furthermore, it is still capable to deliver double the energy in the high power region, within a discharge time of few seconds.