Manganese oxide/graphene aerogel composites as an outstanding supercapacitor electrode material

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Graphene aerogels (GA), prepared with an organic sol-gel process, possessing a high specific surface area of 793 m^2/g, a high pore volume of 3 cm^3/g, and a large average pore size of 17 nm, are applied as a support for manganese oxide for supercapacitor applications. The manganese oxide is electrochemically deposited into the highly porous GA to form MnO_2/GA composites. The composites, at a high manganese oxide loading of 61 wt%, exhibit a high specific capacitance of 410 F/g at 2 mV/s. More importantly, the high rate specific capacitances measured at 1000 mV/s for these composites are two folds of those obtained with samples prepared in the absence of the GA support. The specific capacitance retention ratio, based on the specific capacitance obtained at 25 mV/s, is maintained high at 85% even at the high scan rate of 1000 mV/s, in contrast to the significantly lower value of 67% for the plain manganese oxide sample. For the cycling stability, the specific capacitance of the composite electrode decays by only 5% after 50,000 cycles at 1000 mV/s. The success of this MnO_2/GA composite may be attributed to the structural advantages of high specific surface areas, high pore volumes, large pore sizes, and three-dimensionally well-connected network of the GA support, making possible the high mass loading of the active material, manganese oxide, large amounts of electroactive surfaces for the superficial redox events, fast mass transfer within the porous structure, and well-connected conductive paths for the involved charge transport.