Surface functionalization of vertical graphene significantly enhances the energy storage capability for symmetric supercapacitors

ABSTRACT

Vertical graphene (VG) sheets, which consist of few-layer graphene vertically aligned on the substrate with three dimensionally interconnected porous network, make them become one of the most promising energy storage electrodes, especially for SCs. Nevertheless, the intrinsic hydrophobic nature of pristine VG sheets severely limited its application in aqueous SCs. Here, electrochemical oxidation strategy is adopted to increase the hydrophilicity of VG sheets by introducing oxygen functional groups so that the aqueous electrolyte can fully be in contact with the VG sheets to improve charge storage performance. Our work demonstrated that the introduction of oxygen functional groups not only greatly improved the hydrophilicity but also generated a pseudo capacitance to increase the specific capacitance. The resulting capacitance of electrochemically oxidized VG for 7 min (denoted as EOVG-7) exhibited three orders of magnitude higher (1605 mF/cm²) compared to pristine VG sheets. Through assembled two EOVG-7 electrodes, a symmetric supercapacitor demonstrated high specific capacitance of 307.5 mF/cm², high energy density of 138.3 μWh/cm2 as well as excellent cyclic stability (84% capacitance retention after 10000 cycles). This strategy provides a promising way for designing and engineering carbon-based aqueous supercapacitors with high performance.