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Conductivity and electrochemical charge storage capacity of thermally treated and ion-beam irradiated graphene oxide/12-tungstophosphoric acid nanocomposites

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Performance of carbon nanomaterials in electrochemical charge storage is highly dependent on the conductivity of the material, presence of pseudocapacitive functional groups, porosity and the structure. Graphene oxide (GO) is has interesting surface chemistry and structural properties that can be further modified in different ways. Additionally, 2D nature and different active sites make this material excellent for synthesis of nanocomposites with large variety of compounds. In this work composites of GO and 12-tungstophosphoric acid (WPA) with 6 and 13 wt.% of WPA were synthesized. The obtained material was modified with thermal treatment up to 400 ℃ in argon atmosphere and ion beam irradiation (low energy hydrogen and nitrogen ions 15-75 keV and swift heavy xenon ions 150 MeV). Resistivity of the pristine and modified samples was investigated with solid state electrochemical impedance spectroscopy while galvanostatic charge-discharge was used for assessment of charge storage properties. The results showed that the resistivity of the samples irradiated with hydrogen ions decreased up to fluence of $1\times10^{16}\ ions/cm^2$ after which the increasing structural damage caused the increase in resistivity. Capacitance of pristine and low energy irradiated samples was quite low which was connected to low conductivity of these samples and low penetration depth of the used ions. Thermally treated samples of GO exhibited substantially lower resistivity that was even lower in the case of composites which showed the beneficial influence of WPA on electric properties of GO. These samples also had increased charge storage capacity. Swift heavy ion irradiated samples showed charge storage capacitance comparable to the thermally treated samples whereas the composites showed improved capacity and cycling stability.

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