A wide potential window symmetric supercapacitor by TEMPO functionalized MWCNTs

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ABSTRACT
In this paper, we report a simple and effective method to functionalize industrial-grade multi-walled carbon nanotubes (MWCNTs) with 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO), via oxidation of MWCNT[S] and followed by carbodiimide coupling of amino-TEMPO. The effective coupling is confirmed and studied by EPR, HRTEM, BET, XPS, FTIR, TGA and XRD techniques. Electrochemical studies reveal the capacitive enhancement of MWCNTs-TEMPO, where MWCNTs-TEMPO shows capacitance value (66 F g^{-1} at 0.25 A g^{-1}) that is 5-times higher than that of industrial grade MWCNTs (13.5 F g^{-1} at 0.25 A g^{-1}). This can be due to the reversible redox reaction of nitroxide radicals on TEMPO that contributes to pseudocapacitance. A symmetrical supercapacitor is assembled with MWCNTs-TEMPO as electrode material and optimized with wide operating voltage (2 V) to produce high energy density of 26.6 Wh kg^{-1} with high stability (90% capacitance retention over 4000 cycles). The findings propose a facile approach to modify industrial grade MWCNTs as the electrode materials in supercapacitors.

Keywords: MWCNTs; Functionalization; Nitroxides; TEMPO; Supercapacitance