DOI:10.18311/jsst/2024/xxxxxx
ISSN(Online):0976-9420
ISSN(Print):0970-1893

J.Surface Sci. Technol. *Vol 40 (1-4),pp. 48-59, 2024*

$NiCo_2O_4$-Reduced Graphene Oxide-Activated Carbon Composite for Supercapacitor Application

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Abstract

The growing energy demand has increased interest in renewable energy sources, with supercapacitors emerging as viable alternatives for portable energy storage. Here, we prepared NiCo2O4-reduced graphene oxide-activated carbon composite with varying mass ratios of activated carbon to reduced graphene oxide via a one-pot hydrothermal process followed by calcination. The morphology and composition were analyzed using SEM, XRD, EDX, and FTIR techniques. SEM revealed partial exfoliation of graphite oxide, while XRD showed a cubic phase of $NiCo_2O_4$ with a 6 nm crystallite size. EDX indicated a carbon-to-oxygen ratio of 65.32:31.46, and FTIR confirmed the removal of oxygen-containing groups upon reduction. Electrochemical studies, including cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) experiments, highlighted the pseudocapacitive behavior of the composite. The increase in the relative amountof activated carbon was beneficial to a certain extent and enhanced electrode performance. Notably, the composite material with 20% activated carbon by mass demonstrated the best performance, with a specific capacitance of 460 F g^{-1} at a current density of 2 A g^{-1}. This was attributed to the optimal synergy between activated carbon and graphene sheets, resulting in a more porous structure that enhanced charge storage.

Keywords: Activated Carbon, Carbon-composite, Nickel-Cobalt Oxide ($NiCo_2O_4$), Reduced Graphene Oxide, Supercapacitors