

ABSTRACT

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Title: Characterization of MWCNT/Biochar-MnO₂ Nanocomposites for Supercapacitor Applications and High School Curricular Module Development

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The global push for renewable energy sources, coupled with the continued advancement and miniaturization of digital devices has placed a critical focus on the role and abilities of energy storage technologies to meet these demands. Historically, batteries have been the dominant charge storage device, due to their high energy density; however, the technology is inherently plagued by stability issues, slow charge and discharge times, low power densities and cycle lives.¹ Capacitors, on the other hand, possess high power densities, long cycle life, and fast charging times but have low energy densities and, discharge over short amounts of time.² It therefore appears that the ideal charge storage device would be some hybrid of these two architectures. This project has focused primarily on testing supercapacitor electrodes composed of high surface area carbon and metal oxide nanocomposite material. In particular, pure MnO₂, biochar-MnO₂, and multiwall carbon nanotube (MWCNT)-MnO₂ nanocomposites as electrodes were investigated and found to have high specific capacitances of 129.4 F/g, 197.5 F/g, and 149.4 F/g at 0.5A/g, respectively. Electrodes were characterized through x-ray diffraction (XRD) and transmission electron microscope (TEM)/scanning electron microscope (SEM) imaging before being made into supercapacitor cells and characterized electrochemically through charge/discharge and cyclic voltammetry tests. The results of this original research were used to develop an instructional module containing lesson plans to be offered at the 11-12th grade level. Based on initial studies, biochar-MnO₂ seems to be a promising alternative to MWCNT-MnO₂ while also providing an authentic source of scientific research applicable in the development of high school curriculum.