Void Space Control in Porous Carbon for High-Density Supercapacitive Charge Storage

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ABSTRACT:

High-density charge (energy) storage under supercapacitive mode requires an electrode that would deliver larger space for charge accumulation and offer a larger electrochemical potential difference at an electrode−electrolyte interface. Porous carbon has been a preferred electrode for commercial supercapacitors; however, its charge storability is much lower than that of state-of-the-art charge-storage devices such as lithium-ion batteries. We show that one of the primary limiting factors is the voids in porous carbon, which do not contribute to the capacitance because their sizes are much larger than the size of the solvated/ unsolvated ions in the electrolyte. We partially activate these voids by filling them with a flower-shaped 3D hierarchical pseudocapacitive material (MnCo2O4) by assuming that flower-shaped fillers would provide an additional easily accessible surface for charge adsorption. Less than 10 wt % MnCo2O4 in the porous carbon from palm kernel shells through simple wet impregnation results in a five-fold increase in the charge storability. Laboratory prototypes of symmetric supercapacitors are fabricated using the MnCo2O4-filled carbon electrodes, which show five times higher specific energy than pure carbon and are cycled over 5000 times with >95% capacitance retention. The present strategy of activating the voids by hierarchical 3D nanostructures could be applied to build high-performance energy-storage devices.

DOI: https://doi.org/10.1021/acs.energyfuels.0c00737

ACKNOWLEDGMENTS

This work is funded by the Fundamental Research Grant Scheme of the Ministry of Education, Govt. of Malaysia through FRGS/1/2019/STG07/UMP/01/1. We acknowledge the late Prof. Dato' Dr. Mashitah Mohd Yusoff for her interest in this work