Ferrocene functionalized multi-walled carbon nanotubes as supercapacitor electrodes

Gomaa A.M. Ali[a], Elżbieta Megiel[b], Piotr Cieciórski[b], Mohammad R. Thalji[c], Jan Romański[b], H. Algarni[d,e], Kwok Feng Chong[c]

[a]Chemistry Department, Faculty of Science, Al–Azhar University, Assiut 71524, Egypt
[b]University of Warsaw, Faculty of Chemistry, Pasteura 1, 02-093 Warsaw, Poland
[c]Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Gambang, 26300 Kuantan, Malaysia
[d]Research Centre for Advanced Materials Science (RCAMS), King Khalid University, Abha 61413, P. O. Box 9004, Saudi Arabia
[e]Department of Physics, Faculty of Sciences, King Khalid University, P. O. Box 9004, Abha, Saudi Arabia

ABSTRACT

Modified multi-walled carbon nanotubes (MWCNTs) functionalized by a redox-active ferrocene (Fc-MWCNTs) were successfully synthesized to enhance the electrochemical performance ofMWCNTs for supercapacitor application. The ferrocene moieties were attached to the surface of MWCNTs via a thiourea linker with anionsinteracting capability. The Fc-MWCNTs were characterized using XPS, FTIR, SEM, TGA, DTG, and XRF methods. The electrochemical performance details were investigated using cyclic voltammetry, galvanostatic chargedischarge, and electrochemical impedance spectroscopy. The Fc-MWCNTs electrode showed excellent capacity retention (90.8% over 5000 cycles) and a specific capacitance of 50 F g−1 at 0.25 A g−1 that is several times higher as compared to the pristineMWCNTs. The fabricated Fc-MWCNTs is proposed to be a suitable and promising candidate for energy storage material.

KEYWORDS: Ferrocene**;** Functionalization**;** Multi-walled carbon nanotubes**;** Supercapacitor electrodes

DOI: https://doi.org/10.1016/j.molliq.2020.114064

ACKNOWLEDGMENTS

This work was financially supported by the grant 501-D112-01-1120000 zlecenie nr 5011000370 and National Science Centre, Poland (NCN grant No. 2018/30/E/ST5/00841). In addition, the authors would like to acknowledge the funding from the Ministry of Higher Education, Malaysia in the form of [RDU1901186:FRGS/1/2019/STG07/UMP/02/6] and Malaysia Toray Science Foundation grant RDU201502. Moreover, the authors extend their appreciation to the Deanship of Scientific Research at King Khalid University for funding this work through the research group project under the grant number (R.G.P. 2/115/41). The authors thank Dr. hab. BarbaraWagner (University of Warsaw, Faculty of Chemistry) for performing XRF measurement.