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In situ development of Ru nanoparticles on N-doped template-free mesoporous carbons for high-performance supercapacitors and dye-sensitized solar cells

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Due to the ever-increasing energy demand, fossil fuel depletion and climate change, investigation and development of renewable energy conversion and storage devices have increased around the world. Dye-sensitized solar cells and supercapacitors are considered clean and environmentally friendly energy conversion and storage devices, due to their simple fabrication process and low cost. In this study, in situ Ru nanoparticles (Ru-NPs) are prepared on the N-doped template-free mesoporous carbon through the stabilization and carbonization of poly(butyl acrylate)-b-polyacrylonitrile (PBA-b-PAN) block copolymer with Ru(acac)3. Ru-NPs and N-doped porous carbon are formed simultaneously, where PBA-block act as a porous template, while PAN-block and Ru(acac)3 acts as semi-graphitic carbon and Ru source, respectively. The resulting Ru-NPs on N-doped mesoporous carbon shows a very high specific gravimetric capacitance of 656.25 F g−1 at a scan rate of 10 mV s−1, good rate capability, and excellent long-term cycling stability (almost 100% retention after 5000 cycles) when applied as the electrode in supercapacitors. Furthermore, it shows very good catalytic activity toward the cobalt reduction reaction in DSSC, and optical transmittance properties in the visible wavelength (AVT, 42.25%). When Ru-NPs on N-doped mesoporous carbon were employed as CEs in a bifacial DSSC using SGT-021 sensitizer, a remarkable power conversion efficiency of 10.13 % and 8.64% from the front and rear illumination, respectively, were obtained. Also, a typical DSSC with the resulting CEs shows a PCE of 11.42%.

Biography

M. Aftabuzzaman received his B.S. and M.S. degrees from the University of Rajshahi, Bangladesh. Then, he was rewarded his M.S. degree under the supervision of Prof. Hwan Kyu Kim in the department of advanced materials chemistry at Korea University in 2019. Currently, he is continuing his Ph.D. in the same research group. His current research field is the development of nanostructured carbon-based materials and their application in energy conversion and storage devices.