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Min Su Kim, J Electr Eng Electron Technol 2017, 6:3
DOI: 10.4172/2325-9833-C1-008

General synthesis of N-doped macroporous graphene-encapsulated mesoporous metal oxides and its application as anode materials for sodium-ion hybrid supercapacitors

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Employing graphene as an electrode material is advantageous for energy storage devices because it is flexible, highly electrically conductive and chemically stable and has large theoretical surface area. However, graphene generally suffers from serious agglomeration and re-stacking due to its strong π-π stacking and van der Waals interactions between graphene nanosheets during charge-discharge process. To fully use the potential merits of graphene and improve the kinetics of electrode materials in energy storage devices, composites of graphene and metal oxides have been tested as electrode. Metal oxides in the composites, prevent the re-stacking of graphene. Graphene layers in the composites also suppress the volume change and agglomeration of metal oxide and provide a highly conductive matrix for metal oxide. We report a general method to synthesize mesoporous metal oxide at N-doped macroporous graphene composite by heat treatment of electrostatically co-assembled amine-functionalized mesoporous silica/metal oxide composite and graphene oxide and subsequent silica removal to produce mesoporous metal oxide and N-doped macroporous graphene simultaneously. Four mesoporous metal oxides (WO_{3-x}, Co_3O_4, Mn_2O_3 and Fe_3O_4) were encapsulated in N-doped macroporous graphene. Used as an anode material for sodium-ion hybrid supercapacitors (N_a-HSC_s), mesoporous reduced tungsten oxide at N-doped macroporous graphene (m-WO_{3-x} at NM-rGO) gives outstanding rate capability and stable cycle life. Ex situ analyses suggest that the electrochemical reaction mechanism of m-WO_{3-x} at NM-rGO is based on Na^+ intercalation/de-intercalation. This is the first report on Na^+ intercalation/deintercalation properties of WO_{3-x} and its application to Na-HSCs.

Biography

Min Su Kim has received his BS degree in the Department of Chemical Engineering at Pohang University of Science and Technology (POSTECH), South Korea. He is currently pursuing MS-PhD integrated course in Chemical Engineering at POSTECH. His current research focuses on development and application of functional nanomaterials.

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