Fabrication of metal oxide/graphene nanocomposites for electrochemical capacitors

Hae-Min Lee,[1] Gyoung Hwa Jeong,[2] Sang-Wook Kim,[3] and Chang-Koo Kim[*1]

[1] Department of Chemical Engineering and Division of Energy Systems Research,
[2]Center of Molecular Science and Technology,
[3] Department of Molecular Science and Technology,
Ajou University, Suwon 443-749, Korea

*changkoo@ajou.ac.kr

Electrochemical capacitors (ECs) are attractive energy storage devices because of their high power density, long cycle life, and rapid charging-discharging rates. ECs can be applied in a variety of applications, including consumer electronics, electric vehicles, and medical electronics, military devices, and so on. ECs can be classified into two categories, electrical double-layer capacitors (EDLCs) and electrochemical pseudocapacitor, depending on their energy storage mechanism. Currently, EDLCs contain activatied carbon (AC) with a high surface area as the electrode material, and the capacitance comes from the charge accumulated at the electrode /electrolyte interface. On the contrary, pseudocapacitors use a transition metal oxide or conducting polymers as an electrode material that undergoes fast and reversible faradic redox reactions. Much attention has been paid on the development of advanced electrode materials having high specific surface areas and conductivity.

Graphene is an outstanding candidate as an electrode material because of their exceptionally high specific surface area, excelllent thermal and electrical conductivity, and good chemical stability. However, graphene sheets usually suffer from agglomeration and re-stacking due to the van der Waals interactions, which leads to a great loss of effective surface area and, consequently, capacitance than as expected. In order to enhance the performance of graphene based materials, the combination of double layer capacitance of graphene sheets and pseudocapacitance of the loaded redox-active materials is being investigated.

In this work, graphene-based metal oxide nano-composites were fabricated from graphite in water using a direct and simple hydrothermal method. The morphology and crystal structure of the metal oxide/graphene nanocomposites have been investigated by transmission electron microscopy (TEM), powder X-ray diffraction (XRD), and BET. The electrochemical characteristics of metal/graphene nanocomposite were evaluated by cyclic voltammetry and galvanostatic charge-discharge tests.

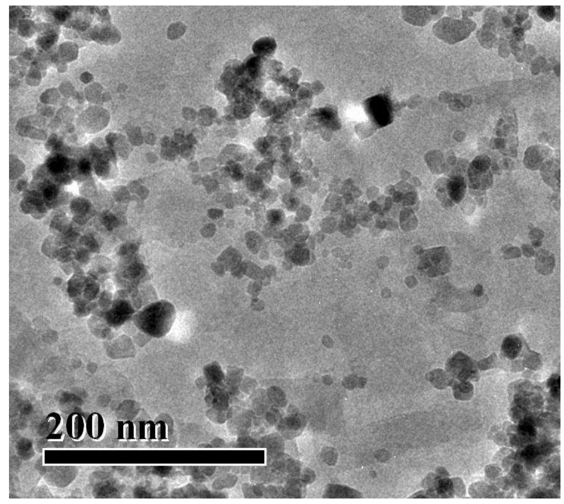

Figure 1. TEM images of Co_3O_4/graphene nanocomposites.