Graphene-based Hierarchical Nanostructured Carbon for High-performance Supercapacitors

Kwang-Bum Kim*, Sang-Hoon Park, Seung-Beom Yoon, Hyun-kyung Kim

Department of Materials Science and Engineering, Yonsei University, Seoul, Republic of Korea.
kbkim@yonsei.ac.kr

Electrochemical capacitors (ECs), also called supercapacitors or ultracapacitors, have attracted great interest during the past decades due to their high power density, long cycle life, and fast recharge capability.[1] The high power density is attributed to the charge storage mechanism of supercapacitor, which is a reversible, fast ion adsorption/desorption reaction at the electrochemical interface between an electrolyte and an electrode. Such a charge storage mechanism requires the electrode material to have not only a sufficiently large surface area but also a high electrical conductivity for achieving the fast and reversible electrochemical reactions.[1]

Among the various electrode materials available for supercapacitors, graphene has attracted considerable interest as a next-generation carbon material owing to its high surface area (~2630 m^2 g^{-1}), superior conductivity and excellent electrochemical stability.[3] In contrast to conventional porous-carbon materials, the ultrahigh surface area of graphene does not depend on the pore structure and distribution in the solid state but comes from open channels between the 2-Dimentional nanosheets. However previous research on the capacitive behavior of chemically prepared graphene nanosheets from graphite (commonly called reduced graphene oxide, RGO) indicates that their actual performance is still lower than the predicted value estimated from the ultrahigh surface area of ideal graphene.[3] In order to solve these problems, very recently, graphene nanosheet combining with other conductive sp^2 carbons (e.g., carbon nanotubes (CNTs), carbon black, fullerene and mesoporous carbon) as a hierarchical nanostructure has been demonstrated as an effective way to develop the gaphene based electrode for electrochemical applications. Owing to their multidimensional structure and three-dimensional conductive networks, hierarchical nanostructured carbons possess large, electrochemically active, surface areas with efficient porous channels and high electrical conductivity, which facilitate fast ion diffusion/electron transfer and can enhance the electrochemical performance of a nanostructured electrode.

Herein, we report a strategy for the synthesis of a hierarchical graphene-based nanostructured carbon material from one-dimensional graphitic carbon nanofibers (CNFs) by controlling the local graphene/graphitic structure. The resultant nanostructured carbon has a unique hierarchical structure of partially exfoliated sp^2 graphitic blocks interconnected by thin graphene nanoplatelets. Owing to the exposed graphene layers and interconnected sp^2 carbon structure, this hierarchical nanostructured carbon possesses a large, electrochemically accessible surface area with high electrical conductivity and exhibits high electrochemical performance. More details on the synthetic procedure and structural/electrochemical properties will be presented at the meeting.

References

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Figures