

“Chemically Reduced Graphene Sheets for Electrochemical Capacitor and Proton Exchange Membrane Fuel Cell Applications”

Dr. Hye Ryung Byon

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日時：2010年9月1日（水） 15-16時

場所：ナノサイエンス実験棟 2階 セミナー室

I present the making of chemically reduced graphene (*rGO*) sheets separated by layer-by-layer-assembled (LbL) multi-walled carbon nanotubes (MWNTs) for electrochemical capacitor applications. Amine-functionalized MWNTs (MWNT-NH₂) and graphene oxide (GO) were alternately adsorbed onto ITO-coated glasses via the LbL assembly method, which were then subject to a 24-h hydrazine treatment at 120 °C in order to convert GO to *rGO*. The MWNT/*rGO* films showed ~6 times greater electronic conductivity in comparison with original MWNT/GO LbL films upon removal of a large number of surface oxygen groups on GO sheets. The specific and volumetric capacitance of MWNT/*rGO* films from cyclic voltammetry measurements in 0.5 M H₂SO₄ were measured to be ~170 F/g_{electrode} and 160 F/cm³ electrode. This specific capacitance of *rGO* films can be attributed to 1) the availability of electrochemically active surface area of *rGO* sheets separated by the MWNTs in the LbL films, and 2) pseudo-capacitive charge storage associated with redox of nitrogen-containing and oxygen-containing surface functional groups on the *rGO* surface. I also present another energy-related application approach of *rGO* for non-noble metal catalysts (NNMCs) in proton exchange membrane fuel cells (PEMFCs). Nitrogen-coordinated Fe ions have been regarded as the most promising NNMC when doped onto bulk porous carbon materials (N-C_{bulk}, Fe-N-C_{bulk}), which accelerated activity of oxygen reduction reaction (ORR). I showed graphene-based Fe-N catalyst (Fe-N-*rGO*) and its catalytic structure, kinetic activity, and stability. The Fe-N-*rGO* catalyst was prepared by 1) mixing graphitic carbon nitride (g-C₃N₄), *rGO*, and Fe ion precursors, then 2) pyrolyzing the mixture at 800 °C for 2 hours in flowing Ar gas. X-ray photoelectron spectroscopy (XPS) revealed that a predominant N molecule was pyridine (~50% among N components). The Fe-N-*rGO* had Fe-N₃ average configuration observed by extended x-ray absorption fine structure (EXAFS) analysis. The Fe-N-*rGO* catalyst showed higher activity than Fe-N-carbon black derived from Fe ion, g-C₃N₄, and carbon black, and high stability in acidic medium.

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Department of Mechanical Engineering, Department of Materials Science and Engineering, Electrochemical Energy Laboratory, Massachusetts Institute of Technology

Time & Date : Wednesday, September 1st, 2010, PM 3:00-4:00

Place : Seminar room, 2nd floor, The Nanoscience Joint Laboratory, RIKEN

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