Characteristics of nitrogen-doped graphene cathode synthesized via microwave-hydrothermal method for Li-air battery

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Lithium-air battery has attracted much attention, because it provides high theoretical energy density than conventional Li-ion battery. However, lithium-air battery has some challenges [1]. The oxygen reduction reaction (ORR) has been considered as one of the critical problems. For increasing ORR activity, various metal catalysts including Pt, Ru and Pd have been investigated despite their high prices [2-4]. Recently, some papers have been reported to overcome the disadvantage of metal catalysts. The papers reveal that nitrogen-doped carbon materials can acted as an effective metal-free electro-catalysts [5].

In recent years, Graphene has been researched widely in various electrochemical energy research areas. Graphene shows outstanding properties such as high specific surface area (2630 m^2/g) and electrical conductivity. The properties are satisfied with requirements of material for electrochemical electrode. For this reason, we synthesized nitrogen-doped graphene cathode for lithium-air battery. In this study, the nitrogen-doped graphene was synthesized from graphene oxide (GO) using ammonia solution via microwave-hydrothermal process. The GO was dissolved in DI water, and then ammonia solution was dropped into the GO dispersed solution. The mixed solution was transferred into a sealed Teflon autoclave for synthesizing nitrogen-doped graphene via the microwave-hydrothermal process. The Teflon autoclave was heated at 373-423 K for few minutes. The assistance of microwave can significantly reduce the synthesis time compared to conventional hydrothermal method. After synthesis process, the treated solution was washed with DI water and dried. The collected sample was denoted as NDG.

In order to observe the morphology of samples, scanning electron microscopy (SEM) [JEOL-JSM7100F] was carried out **(Figure 1)**. The X-ray diffraction (XRD) patterns were obtained from Rigaku SmartLab using Cu-Kα radiation (λ=1.5406 Å) from 3 ° to 70 ° at a scan step of 0.02 °. Raman spectra were recorded by Horiba Aramis Raman spectroscopy at an excitation wavelength of 532nm. And we investigate the chemical composition of synthesized nitrogen-doped graphene by X-ray photoelectron spectroscopy (XPS) [ThermoFisher Scientific K-alpha]. In addition, the bonding configuration of nitrogen atoms in graphene layers was characterized by high resolution XPS spectrum of N1s peak. Electro-catalytic activities of the samples were characterized by conventional three-electrode system. A glassy carbon electrode was used as working electrode, and a Pt electrode and an Ag/AgCl electrode were used as counter and reference electrodes, respectively. RDE voltammetry was carried out on an AFMSRCE rotator (Pine Instrument). Evaluation of electrochemical performances in a lithium-air cell was facilitated using a multichannel potentiostat (Princeton, Versastat-4). The results of electrochemical measurements suggest that nitrogen-doped graphene synthesized via microwave-hydrothermal method has great potential as an effective metal-free electro-catalytic cathode material for lithium-air battery.

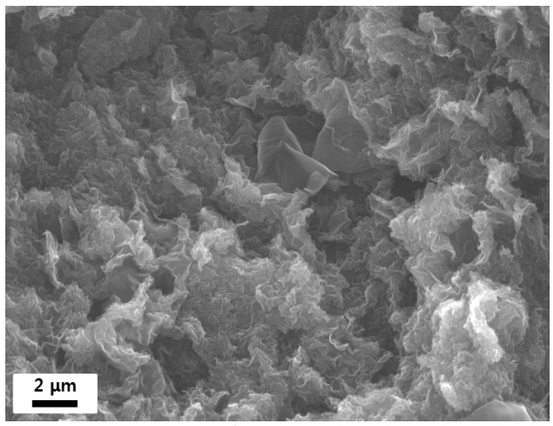

Figure 1. SEM image of nitrogen-doped graphene (NDG) synthesized via microwave-hydrothermal method

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