Electrochemical synthesis of nitrogen doped graphene for oxygen reduction and supercapacitors

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Abstract

Graphene, a two dimensional monolayer of sp2-hybrided carbon sheet, has received wide attention due to its huge specific surface area, high chemical stability, excellent thermal and electrical conductivity, great mechanical strength, and inherent flexibility as well as ultrahigh electron mobility. However, the zero band gap characteristic limited the wide application of graphene. Fortunately, the introduction of heteroatoms into graphene presents the potential to tweak its electronic and electrochemical properties by changing the electronic density within the graphene sheet. [1] In previous reports, nitrogen doped graphene was either prepared from graphene or graphene oxide by post treatment, such as thermal, plasma, or hydrothermal treatment, or obtained through a bottom up approach, such as chemical vapor deposition or hydrothermal process.[1] Therefore, developing a low-cost, scalable, and ecofriendly method is still of great interest.

A one-step electrochemical method to produce bulk quantities of nitrogen doped graphene was developed in this work. The simultaneous production and nitrogen doping of graphene was realized by electrochemical exfoliation of graphite foil in the nitrogen containing sulfate salt electrolyte. The highest doping level of about 5 at% N can be achieved (Figure 1A). The mechanism of nitrogen doping was proposed based on analysis the exhausted gas and the obtained graphene. The obtained nitrogen doped graphene was tested as catalyst for electrochemical oxygen reduction reaction and as electrode for supercapacitors which shows improved performance (Figure 1B and C).

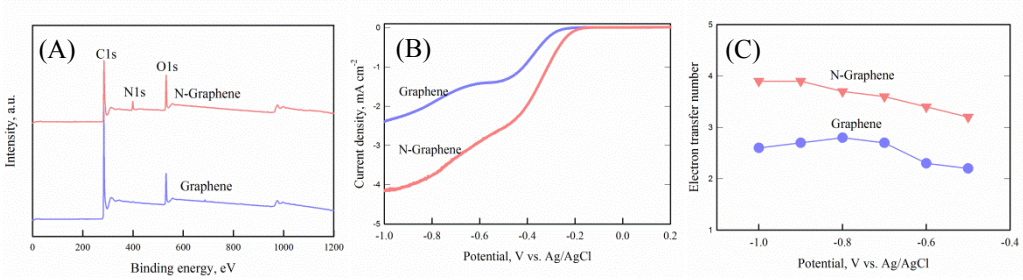

Figure 1, XPS spectra (A), RDE measurements (B), and electron transfer number (C) of Graphene and N-Graphene.

References

[1] Higgins, D. C.; Hoque, M. A.; Hassan, F.; Choi, J.-Y.; Kim, B.; Chen, Z., ACS Catalysis, **4** (2014) 2734-2740.