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Synthesis and characterization of Graphene Nanoribbons Prepared by one-step electrolytic exfoliation

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Graphene nanoribbon (GNR), a narrow stripe of graphene layer, has recently gained much attention due to its special electronic band gap and very large surface to volume ratio properties promising for numerous applications such as graphene-based electronic devices, energy storage and electromechanical sensors. GNR can be fabricated by several methods including unzipping of carbon nanotubes, chemical synthesis through sonication of exapandable graphite, chemical vapor deposition on template and hydrothermal synthesis using ferrocene. In this work, we report a new method for one-step synthesis of GNR based on electrolytic exfoliation process. In this process, a constant potential of 8 V was applied between two graphite rods immersed in PEDOT:PSS electrolyte containing 0.05 M HNO3 for 24 hours and the supernatant portion of the dispersion was centrifuged at 1200 rpm to remove large agglomerates. From scanning/transmission electron microscopic characterization, the dispersed products in PEDOT:PSS solution with HNO3 addition have uniform nanostripe structures having width and length in the ranges of 5-15 and 200-300 nm, respectively while those prepared in pure PEDOT:PSS solution have typical graphene flake structures with random shape and size distribution. The number of graphene layers of GNRs was found to be in the range of 5-10 by high resolution TEM. Raman spectra of the products confirm graphene structure with distinct G and 2D peaks at 1574 and 2660 cm-1, respectively. In addition, Fourier transform infrared spectroscopy demonstrate polymer free-graphene after graphene extraction from the solution. Therefore, the new organic solution-based method is attractive for GNR fabrication due to its high reproducibility, simplicity, low cost, low temperature processing and ease of large-scale production.

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