Large scale production of few layer graphene from novel plasma reactor system.

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Abstract

Among a variety of techniques currently employed, solvent exfoliation of graphite and chemical vapor deposition have lately been established as the two main methods for graphene synthesis. While these methods have improved greatly over the past few years, they still do not provide a reliable way for graphene production on a large scale.

We are presenting a novel method of catalyst-free continuous large scale production of graphene from a gaseous hydrocarbon feedstock in our proprietary plasma reactor system. Controlling the operation parameters of the non-equilibrium inert/hydrocarbon gas plasma from our in-house designed systems allows for hydrocarbon conversion efficiencies of up to 90 % at flow rates of up to 25 L/min. The process allows for graphene production at 100 g graphene per hour.

We are showing the strong dependence of crystallinity and morphology of the product on plasma properties according to varied gas composition, power rating and other operating parameters. Transmission electron microscopy (see figure) was employed to determine the nanostructure of material from different sets of parameters. A large fraction of the product was found to be graphene with one to few layers. Sample crystallinity was determined by Raman spectroscopy and thermogravimetric analysis. BET surface area measurements of as synthesized samples reached up to 300 m^2 g^{-1} from N_2 adsorption corresponding to stacks of about 15 graphene sheets. Small amounts of a gaseous by-product evolved during plasma processing was qualified and quantified by gas chromatography.

Figures

Transmission electron micrographs of graphene sample from plasma reactor at indicated magnification.