Characterization of solution processable graphene

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NRC's Nanocarbon Metrology project aims to develop characterization methods and protocols for the assessment of single wall carbon nanotubes and graphene. As these materials move from the laboratory to production and into applications, there is a need for improved characterization methods and development of standard protocols to ensure material quality. Variable quality of commercially available materials and lack of proper methods and protocols to evaluate these materials is hampering the development of applications.

Many applications (i.e. printable electronics, batteries, graphene-polymer composites,…) require graphene in solution. In this case the graphene is in the form of flakes dispersed in organic or aqueous solvents. Solution processable routes to graphene generally fall into two categories- direct exfoliation of graphite or oxidation to graphene oxide (GO) followed by reduction to graphene. Properties of films made from these dispersions are dependent on both the quality of the individual flakes and how they are assembled into films. Here we will present results on evaluating the structure, morphology and electronic properties of reduced GO and graphene films derived from various protocols using starting materials from a variety of commercial sources. Size of individual flakes in solution have been measured by dynamic light scattering and compared with atomic force microscopy (AFM) measurements after deposition on a substrate. AFM height measurements have been used to determine flake thickness and monitor the thermal reduction of GO to graphene. Scanning tunneling microscopy has been used to observe the atomic scale structure of the flakes. AFM and Raman spectroscopy have been used to characterize the morphology and uniformity of continuous films assembled from these flakes. These observations are correlated with measurements of the conductivity and work function. The structure and electronic properties of films derived from thermal and/or chemical reduction of GO are compared with those based on dispersions of directly exfoliated graphene flakes.