Optimal conditions for the large-scale generation of graphene-based materials through thermal exfoliation of graphite oxide films

Cintia J.B. DeCastilho, Sara Berhane, Robert Hurt and Indrek Kulaots

School of Engineering, Brown University, 184 Hope St., Providence, RI, USA, 02912

Thermal reduction of bulk or film form graphite oxide (GO) is an attractive technique for large-scale production of GO-derived materials for sensor, catalysis, separation and gas storage applications. Our earlier results have shown that the violent explosion of the GO 'cake' (a solid bulk GO) during the thermal exfoliation is not necessarily desirable for achieving high surface area and porosity rGO product. Due to early release of the internal pressure the product gases (H_2O, CO, and CO_2) have no time to generate porosity during the exfoliation, and therefore the rGO obtained has a modest surface area (~400 m^2/g). GO flexible films with a variety of thicknesses do not experience the early release of product gases in exfoliation and those, are able to provide fairly porous rGO films. We have prepared uniform thickness drop-cast, membrane, and wrinkled GO films applying modified Hummers method graphene oxide solution. Drop-cast and wrinkled GO films at low instrument external heating rates undergo non-explosive decomposition. The rGO product film possesses modest surface area and porosity. Above the critical instrument external heating rate, the decomposition of the GO films switches to the explosive mode and produces powder rGO product with fairly large surface area (~800 m^2/g) and porosity. Independent of GO film thickness, the explosive mode thermal exfoliation leads to the rGO powder with more-or-less the same surface area and porosity. These results are important for optimizing the conditions for large scale fabrication of rGO with tailored properties for a variety of applications.