Development of a technique based on methylene blue for characterizing specific surface area of graphenes and other carbon nanostructures

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One of the greatest difficulties when developing methods to produce graphene is assessing the quality of the material produced. The specific surface area is one property that can be used and is particularly useful if the graphene is to be used in a catalytic application (such as the counter electrode in a dye solar cell) where the surface area gives an indication of the number of active sites available for catalysis.

The theoretical surface area of a single graphene sheet is $2630m^2$ per gram and that of a closed single walled carbon nanotube is $1315m^2/g$ [1]. However, when making graphene in quantities greater than single flakes, this theoretical surface area is difficult to attain due to the presence of multiple layer nanoplatelets as well other impurities.

Nitrogen adsorption is the most commonly used method for assessing surface area with a number of commercially produced systems available for this purpose. This technique requires a bulk sample for assessment of at least $5m^2$ and the samples must be in solid form. A methylene blue technique has the advantage of no minimum sample size and can directly measure samples dispersed in a liquid.

Previous methods for assessing the surface area of graphene by methylene blue [2] have required the graphene to be suspended in ethanol and filtered and had some discrepancy with the nitrogen absorption measurement. This work develops the methylene blue method using water as the solvent and removing the need for filtration.

1. Peigney, A., Laurent, C., Flahaut, E., Bacsa, R.R. & Rousset, A. Specific surface area of carbon nanotubes and bundles of carbon nanotubes. *Carbon* **39**, 507-514 (2001).

2. Mcallister, M.J. *et al.* Single sheet functionalisation by oxidation and thermal Expansion of Graphite. *chem. materials* **19**, 4396-4404 (2007).