Graphene Oxide and Graphene Oxide Derivatives. Properties and Applications

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Abstract

Graphene oxide (GO) is prepared by oxidation of graphite, by a variety of methods, most often modifications of the "Hummers method". The resulting materials vary in sheet size according to the graphitic raw material crystal size, but the degree of oxidation is fairly constant at C/O = around 2. In its virgin state, GO is a highly oxidized solid acid easily dispersible in polar solvents as single layers 1 nm thick.
GO can be reduced to become more or less graphene-like rGO, by thermal, chemical or light induced reactions. Thermal reduction leads to a reduction in mass of up to 2/3, indicating that most of the oxidized regions disintegrate, resulting in the release of CO and CO_2 (Fig 2). Both GO and rGO can be de-acidified, nitrogen doped and functionalised to obtain new properties. GO and GO-derivatives have been reported to have potential for a range of applications, such as corrosion protection, water treatment, composites, lubricants, energy storage, photo-catalysts, sensors, sports equipment, medical and load speaker membranes.
From an industrial perspective, concerns, apart from relevant chemistry are costs, availability and hazards. Costs will inevitably come down with increased production volumes, to as little as 1 % of todays price, according to our estimates. Regarding hazards, the picture is not yet clear, as several recent studies indicate that GO-sheets can penetrate cell membranes.

Figures

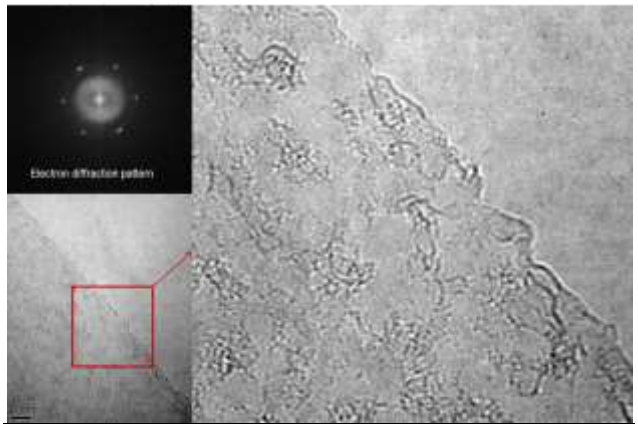

Figure 1: TEM-image of graphene oxide single sheet. Oxidized and non-oxidized regions can easily be recognized. Electron diffraction pattern insert confirms single sheet.

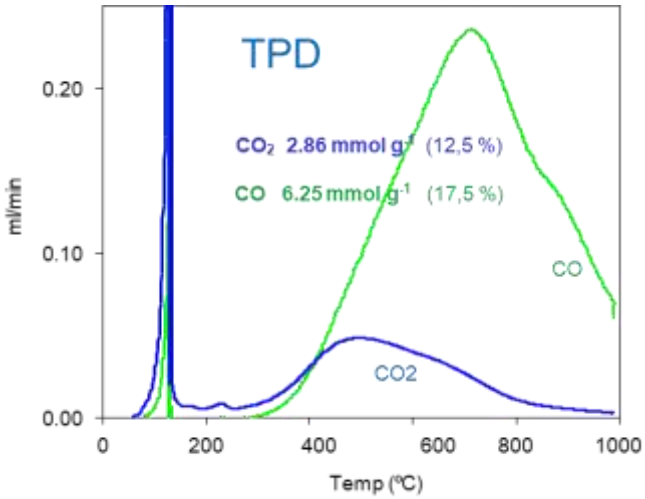

Figure 2: Temperature Programmed Desorption of graphene oxide.