

# Additive Free, Single Layer Graphene in Water & Few Graphene layers from Food Waste

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(i) Full exfoliation of graphite to form thermodynamically stable, negatively charged, graphene (graphenide) flakes in solution can be achieved by dissolution of graphite intercalation compounds (GICs) in low boiling point aprotic organic solvents under inert atmosphere [1]. We now report that, under certain conditions, graphenide can be transferred to water as single layer graphene. The organic solvent can then be evaporated to remain with an aqueous graphene suspension of ca 0.1 mg/ml concentration under ambient atmosphere. The Raman spectra (2.33 eV laser) collected in situ on such dispersions show bands at 1343, 1586, 1620 and 2681  $\text{cm}^{-1}$  corresponding to the D, G, D' and 2D bands of graphene respectively. The 2D band at 2681  $\text{cm}^{-1}$  is well fitted with a sharp lorentzian line ( $\sim 29 \text{ cm}^{-1}$ ) which is a hallmark of single layer grapheme [2]. We have thus succeeded in preparing air stable, bulk suspensions of single layer graphene in water [3].

(ii) Food waste can be transformed into graphitic carbon and renewable hydrogen using an innovative low energy microwave plasma process at industrial scale. The obtained nanocarbon is obtained through energy efficient transformation of methane resulting from decomposition of food waste [4]. After purification, well defined, high concentration aqueous dispersions of nanocarbons are obtained and characterized. They contain calibrated multilayer graphene particles. Conducting inks and films can be prepared from these dispersions.

## References

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- [2] Y.Y. Wang et al. *J. Phys. Chem. C.*, 112(29), 10637, (2008).
- [3] G. Bepete, C. Drummond, A. Pénicaud, European patent, June 12, 2014, EP14172164
- [4] European community funded FP7 project PLASCARB. <http://www.plascarb.eu/>