Visualisation of graphene surface via nanodiamond fluorescence

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We report using simple dip-coating technique to cover the surface of graphene with fluorescent nanodiamonds (ND) via electrostatic self-assembly. Combining the outstanding electrical properties of graphene and the fluorescent properties of nanodiamonds allows us to optically visualize micro- and nano-size patterns and defects on graphene. Most important part of the immobilization process is the pre-functionalization of ND and graphene surfaces to obtain correct charging which aids the self-assembly.

Three different types of nanodiamonds were used: 1) DND: commercially available detonation ND-s (Ø 40 nm (agglomerates), 1-4 N-V centers, zeta potential +30 mV) in methanol, 2) ND@MSN: mesoporous silica (MSN)-coated ND cores (Ø 210 nm, zeta potential -30 mV) in acetone [1], 3) ND@MSN-PEI: polyethylene imine-functionalized MSN-coated ND cores (Ø 220 nm, zeta potential +42.5 mV) in acetone [1]. Commercially available CVD graphene on SiO_2/Si was used as substrate.

Coating CVD graphene on SiO_2/Si substrate with DND in different solvents with different substrate plasma surface treatments were carried out to investigate the optimal parameters for most efficient and selective surface covering. The nanodiamonds were ultrasonically dispersed to eliminate agglomeration and Raman spectra of the graphene surface were measured to recognize the changes due to plasma surface treatment. The best results for small DND-s were obtained by using methanol solution, as suggested in [2], treating DND-s in hydrogen and graphene substrate in oxygen plasma. Obtained samples were characterized by scanning electron microscopy and fluorescence imaging.

References

1. von Haartman, E. *et al*. J. Mater. Chem. B. **1**, 2358-2366 (2013)
2. Hees, J., Kriele, A., Williams, O.A. Chem. Phys. Lett. **509**, 12–15 (2011)