New techniques to improve the visibility of Graphene on multiple substrates

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The mechanical exfoliation of natural graphite crystals is one of the foremost methods to gain high – quality graphene monolayer flakes, which are crucial for the investigation of its fundamental properties as well as for the development of electronic micro-circuits, nanophotonic assemblies and other microstructured graphene based devices. Although the visualization of the monolayer graphene is hampered by its low absorptivity, it is essential to develop techniques, which reliably and rapidly deliver images of graphene and graphene based structures.

A multitude of optical techniques have been investigated to this end, for example based on interference enhancement on specifically prepared substrates. Other imaging methods are based on Raman and Rayleigh scattering, or on fluorescence quenching of dyes by graphene layers. Generally these methods require relatively complex equipment or an optimized substrate coating. Here, we report on novel and easy to use techniques for the identification of potential graphene flakes.

The first method is long known as microdroplet condensation technique or breath condensation technique. It has previously been used in the context of visualizing hydrophobicity differences on patterned film structures such as self-assembled monolayers. Likewise, the hydrophobicity difference between the substrate and the carbon sheets produce a clearly visible condensation pattern, that singles out the graphene flakes. The effect can be seen on a wide variety of substrates without the need for any specific surface modification or preparation. It can be used on surfaces for which no other method is known such as plastics and uncoated metals. Similarly the contrast enhancement can also be observed in an optical transmission microscope, in which graphene flakes are notoriously difficult to observe.

The second method is based on contrast enhancement by refractive index matching. The graphene flake is immobilized on a dielectric substrate, and by using a refractive index matching liquid the reflection from the substrate is greatly diminished, thereby enhancing the contrast of the monolayer or few-layer graphene. An estimation of the number of layers also becomes possible.

References

[1] Hugo Gonçalves, Michael Belsley, Cacilda Moura, Tobias Stauber and Peter Schellenberg Appl. Phys. Lett., **97** (2010) 231905.