Interesting Properties of Strained and Defective Graphene

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Most people think of graphene as a flat membrane and the quality of physics observation depends on the flatness of it. However defective or strained graphene can present interesting properties, especially to a chemist. For example, generating pores or voids in graphene, oxidizing and disrupting the conjugation, as in the case of nanoporous graphene oxide, can generate a material that is catalytically active – what the chemists called "carbocatalyst". Nanoporous graphene oxide can mediate a wide range of chemical transformation. We have managed to identify a simple chemical treatment to introduce porosity and tune the acidity of Graphene Oxide (GO). This is a potentially important area for industrial applications [1]. The GO catalyst can be used in oxidative coupling reactions as well as tandem catalytic reactions.

Generating strain textures on graphene allows the engineering of new energy landscape. The Dirac electrons in graphene couples to strain via pseudomagnetic field, creating an electrodynamics that is controlled by the geometry of the strain. Using the graphene Moiré superlattice, geometrically precise nanobubbles can be generated that show pseudomagnetic field in the hundreds of Telsa [2]. We discuss the chemistry of how such strain texture can be created by controlling sub-surface defects on the metal substrate. Nanobubbles on graphene can also be created when graphene is transferred onto diamond. Very robust interfacial bonding between diamond and graphene allows a hydrothermal anvil to be created at the interface. Superheated water trapped at the interface becomes corrosive at high temperature and pressure and can etch diamond [3]. By monitoring the conformational changes of pressure-sensitive molecules , the pressure within the nanobubble could be tracked as a function of temperature and was found to be at ~1 GPa at 600 deg C. The polymerization of buckminsterfullerene(C_{60}), which is symmetrically forbidden under ambient conditions, was observed to proceed in well-defined stages in the pressurized nanobubbles.

References

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