Graphene Carbocatalysts and Nanobubbles

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Graphene's quality is often thought to be flatness-dependent, but defective graphene actually has a number of interesting chemical properties. Of particular interest is generating pores or voids in graphene, and oxidising and disrupting the conjugation to produce a catalytically active material, or carbocatalyst.

A team led by Prof Loh Kian Ping of the Department of Chemistry recently identified a simple chemical treatment that introduces porosity and tunes the acidity of graphene oxide. This graphene oxide catalyst can be used in oxidative coupling and tandem catalytic reactions, and thus has many potential industrial applications. In addition to enhancing the performance of oxidative dehydrogenation reactions, this significant research development offers insight into how graphene oxide's acidic groups and unpaired electrons act in concert during catalytic processes.

In another graphene-related development, Prof Loh's team discovered a new way of generating static pressure by encapsulating single-crystal diamond in a graphene membrane. As graphene is impermeable, the hybrid interface acts as a hydrothermal anvil cell. Most surprisingly, the superheated water trapped within the pressurised graphene nanobubbles etched the diamond surface, producing high-density square-shaped voids. This graphene-diamond hydrothermal anvil is a useful bench-top construct for investigating the dynamic chemistry of supercritical phases in fluids.

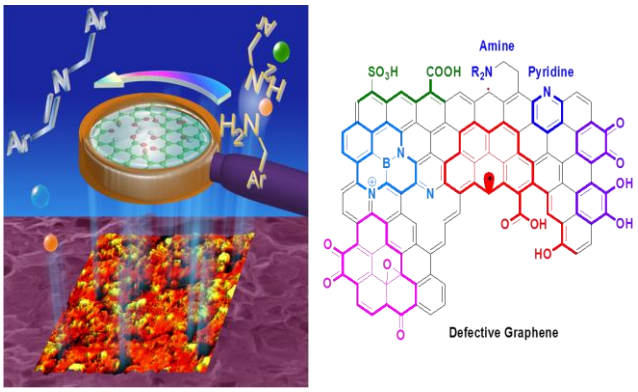

Fig. 1. The defective nature of graphene oxide sheets renders them useful for catalysis or functionalisation with a complex cocktail of functional groups.

Publications:

Su, C.L., Acik, M., Takai, K., Lu, J., Hao, S.-J., Yi, Z., Wu, P.P., Bao, Q., Enoki, T., Chabal, Y.J., and Loh, K.P., Probing the catalytic activity of graphene oxide and its origin. *Nature Communications* 3(1298), doi: 10.10038/ncomms2315 (2012).

Lim, C.H.Y.X., Sorkin, A., Bao, Q., Li, A., Zhang, K., Nesladek, M., and Loh, K.P., Hydrothermal anvil made of graphene nanobubbles on diamond. *Nature Communications* 4(1556), doi: 10.1038/ncomms2579 (2013).