Graphene functionalization: a sure deal?

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Functionalization of carbon based materials such as graphene and carbon nanotubes has shown to be a promising tool for designing novel materials. Can this approach always be a sure deal and guarantee optimal features? Our research group has been engaged in various functionalization of graphene oxide and carbon nanotube seeking several applications mainly involving (i) pesticide degradation and monitoring; (ii) hydrogen production and (iii) improved electrochemical stability. Targeted for pesticide degradation and monitoring, we obtained nanocatalysts derived from graphene oxide (GO) and carbon nanotube with various groups covalently (imidazole, thiol, hydroxamate), obtained as powder and also as thin film. Moreover, bifunctionalization has also been carried out: two different neighbouring groups. Further, nanocomposites com silver nanoparticles were obtained with the thiol-derived GO. The designed nanocatalysts evidenced high catalytic activity against various organophosphorus compounds, up to 10^8-fold enhancements compared to the spontaneous reaction.[1] Reactions that would take millions of years took solely 10 days in the presence of the catalysts. Another catalytic application was hydrogen production using $NaBH_4$.. Several nanocomposites derived from GO, Ag NPs and Ni NPs, as thin film and evidenced a pronounced catalytic activity using low amounts of nanocatalysts (~0.1–0.8 mg), with the maximum rate of hydrogen production reaching nearly 33 $x10^3$ mL^{-1} min^{-1} g^{-1}.[2] These nancatalysts were reused for 10 consecutive cycles without losing activity. Finally, seeking improved electrochemical stability, we have obtained polymeric nanocomposites of GO and polypyrrole (Ppy) that are covalently linked and evidenced a significantly higher electrochemical stability, in contrast to analogous non-covalent composites.[3] In summary, functionalization can indeed be a sure deal for many applications. It has great potential since its multifunctionality can be modulated according to the functionalization approach. The nanocatalysts are also being applied as sensors for detecting toxic agents, such as pesticides and chemical warfare simulants.

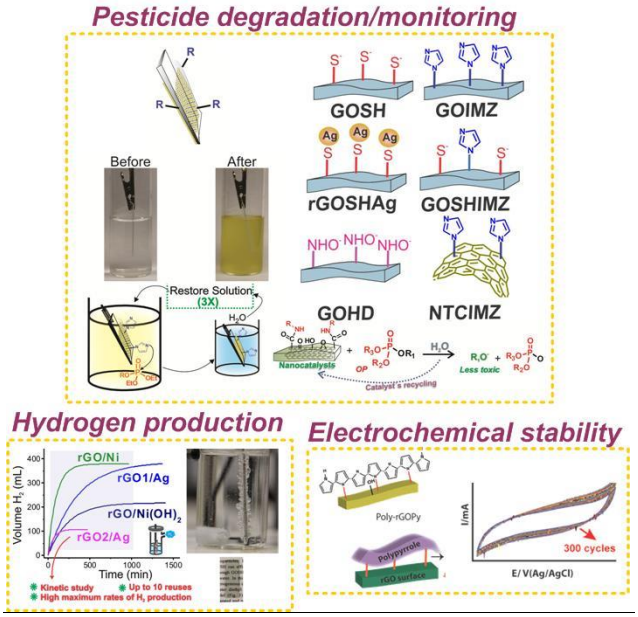

Figure 1: Various functionalization approaches adopted

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