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Graphene-Derived Catalysts for Efficient Detoxification of Organophosphates

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Organophosphates are a class of compounds derived from phosphoric acid esters which are used as pesticides and chemical warfare, such as glyphosate and VX, respectively. Its toxicity and stability highlight the need for control, monitoring and degradation studies. With that in mind, three novel graphene oxide (GO) derived materials were developed for the catalysis of the dephosphorylation reaction of pesticides, with one of these materials also being able to perform the detoxification of byproducts through the conversion of nitrophenol to aminophenol. GOSH and GOCys were obtained from the functionalization of GO with cysteamine and cysteine, respectively by epoxide ring opening reactions [1]. The nanocompositee Ag-GOSH was produced from GOSH with silver nanoparticles doping [2] (Figure 1). All materials were characterized by scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), thermogravimetric analysis (TGA), Fourier transformed infra-red spectroscopy (FTIR). The kinetics of the dephosphorylation reaction were obtained utilizing the organophosphate simulant diethyl-2,4-dinitrophenylphosphate (DEDNPP) monitoring through UV-Vis spectroscopy the appearance the 400nm absorption band that indicates the nitrophenolate formation. The nitrophenolate to aminophenolate reduction reaction was monitored by the disappearance of the 400nm band and the formation of a new band around 300nm. All three nanocatalysts were able to break the phosphorous bond through a nucleophilic attack and Ag-GOSH, due to its silver nanoparticles (AgNPs), catalyzes the reduction of nitrophenol byproducts, thus achieving sequential two-step reaction of total neutralization of organophosphates (Figure 1).

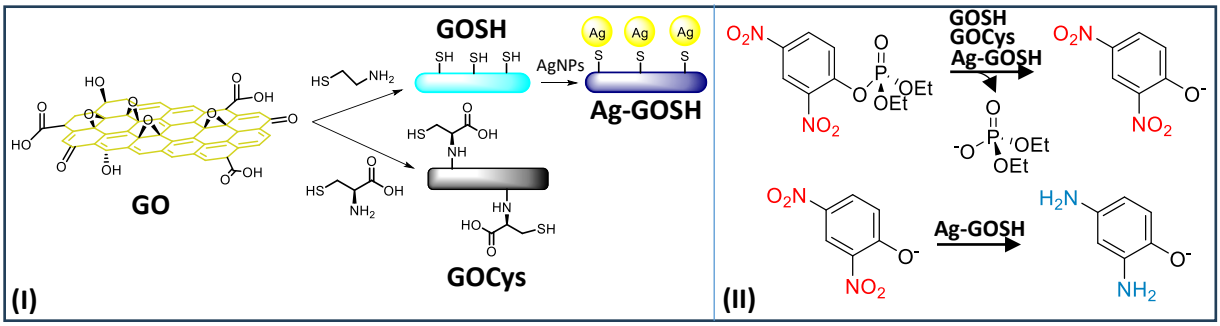

Figure 1. (I). Schematics for the GO functionalization; **(II).** Schematics for the dephosphorylation reaction and dinitrophenolate reduction reaction.

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