Carbon nanostructure-based nanocatalysts for organophosphate degradation

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Carbonaceous-based materials, such as graphene and carbon nanotubes (NTC) are known for their multifunctionality. Functionalization of these materials has shown to be an important tool to modulate their application, for example for catalysis. These materials can comprise many oxygenated sites that by means of covalent functionalization are ideal for anchoring functional groups that can furnish catalytic activity, with enhanced synergistic effects. Herein, we present the targeted functionalization of graphene oxide (GO) and NTC to obtain nanocatalysts that were used to promote degradation of organophosphates (OP), Figure 1. OP are present in several pesticides and chemical warfare, comprising a worldwide health concern. Functionalization was carried out by anchoring imidazole and thiol groups on the carboxylic acid groups of the nanomaterials using 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC), N-hydroxysuccinimide (NHS) and 1-(3-aminopropyl)imidazole or cysteamine.[1] The nanocatalysts were obtained as a solid[1] and thin film, with the later obtained using the interfacial method.[2] The nanocatalysts were evaluated in the cleavage of the model substrate diethyl 2,4-dinitrophenyl phosphate (DEDNPP) by UV-Vis spectroscopy.[3] Impressive rate enhancements of 10^6-fold were obtained, among the highest reported for these heterogeneous reactions. The nanocatalysts were reused for 3 cycles and their catalytic activity was maintained confirming their recyclable features. We highlight the facile recovery and easy handling for two classes of nanocatalysts obtained: (i) thin film that can be immersed in the reaction medium and consecutively washed and (ii) solid with magnetic properties, guaranteeing recovery with a magnet.

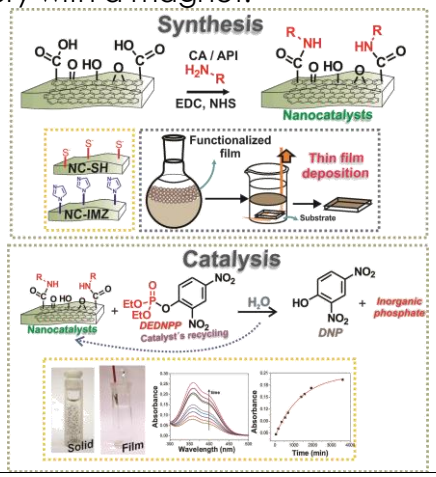

Figure 1: Present Study

We were also focused on the elimination of the toxic pesticide Paraoxon, which showed 10^7-fold enhancements. Thus, we were able to accelerate a reaction that would take over 3 million years to nearly 30 days. Overall, we show the strategic design of nanocatalysts for degrading OP, which are responsible for many serious health issues such as poisoning and abusive usage. Therefore, the nanocatalysts are promising for developing devices for monitoring and detoxifying OP.

References

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