Designing multifunctional graphene-based thin films through interfacial functionalization

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Graphene oxide (GO) surfaces are highly covered with oxygenated groups that may be targeting sites to anchor specific groups, *i.e.* chemical functionalization.[1] Thus, materials with enhanced properties may be furnished and diversified applications could be associated to one single material. Herein, the carboxylate sites of GO were selectively modified with cysteamine (CA) through amide bonds and, in the following, nanocomposites with silver nanoparticles (Ag-NPs) were obtained. The methodology was based on two approaches, involving the novel interfacial functionalization,[2] which led to materials with varying degree of functionalization: (i) at first, a GO film in a liquid-liquid interface was reacted and functionalized with CA,[1] leading to GOSH1, and (ii) in the second route, a deposited GO film was directly functionalized in a sealed vessel containing CA, resulting in GOSH2. The nanocomposites (rGOSHAg) were obtained by the direct heterogeneous reaction of Ag^{+} with the films. All samples were fully characterized by Raman and infrared spectroscopy, X-ray diffraction and scanning electron microscopy. Besides, we addressed a thorough study regarding multiple applications: as nanocatalysts for organophosphate degradation, non-electrochemical sensor for nitrophenols and as SERS substrates (Figure 1). The degradation of organophosphates by the thin films was evaluated through UV-Vis spectroscopy. An impressive catalytic activity was observed ($k_{cat}/k_{non} = 10^6$) for the highly toxic pesticide Paraoxon, which is among the highest reported for analogous heterogeneous systems. Specially, we highlight the facile manipulation and recovering of the thin film employed in the catalysis. Interestingly, the degradation product adsorbed on the composite nanocatalyst was detected by Raman spectroscopy, hence comprising a SERS sensor for nitrophenol, which infers catalytic and sensoring features for one single material. Finally, the nanocomposites presented impressive performance as SERS substrates, detecting 10^{-10} mol L^{-1} of 4-aminotiophenol, which represents an enhancement factor of 10^8. Overall, we show strategic design of multifunctional graphene-based thin films through a novel approach, leading to materials with specific characteristics.

References

[1] Orth, E. S., Fonsaca, J. E. S., Domingues, S. H., Mehl, H., Oliveira, M. M., Zarbin, A. J. G. Carbon, 61 (2013) 543.
[2] Salvatierra, R. V., Oliveira, M. M., Zarbin, A. J. G. Chem. Mat., 22 (2010) 5222.

Figures

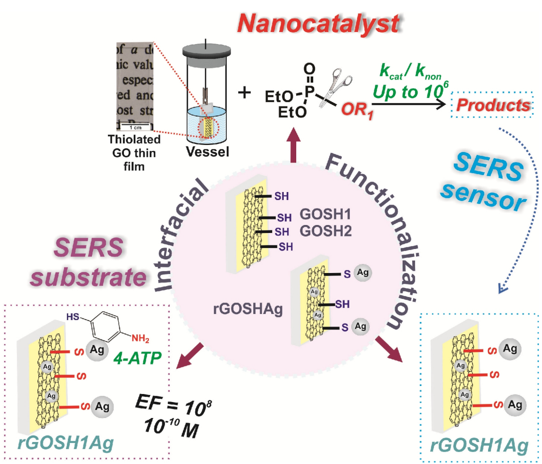

Figure 1: Overall summary of the present study.