Highly-controlled graphene functionalization as a platform for robust nano-bio-hybrid interfaces

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Although pristine graphene is one of the most relevant materials this decade, several important shortcomings must be overcome before it can step from fundamental physics to applied technology. In particular, its extreme chemical inertness and the absence of an electronic band-gap present important limitations to its use as an active element in electronic devices and hybrid structures. Thus, technologically useful and robust graphene-based interfaces for nano-bio-hybrid devices require highly selective, stable and covalently bonded functionalities on the graphene surface, but in order to be effective and competitive they must essentially retain the electronic properties of the pristine graphene surface. There have been many attempts to modify graphene via non-destructive methodologies that aim to preserve its extraordinary properties and incorporate added value. In this talk, we describe a relatively straightforward route to the covalent chemical functionalization of graphene sheets, with any amino containing molecules, as anchoring group. [1]. We employ a recently reported and patented strategy [3] for the selective functionalization of graphene through the controlled formation of atomic vacancies (Fig. 1a), obtaining a graphene surface uniformly covered with a covalently bound spacer molecule that is formed from the spontaneous bonding of, for example, *p*-aminothiophenol (pATP) molecules at the vacancies. The result is a controlled decoration of the graphene surface with active thiol moieties, which can subsequently be directly used to bind diverse nanoarchitectures to graphene. We have used this strategy to covalently couple two systems of broad interest: gold nanoparticles (Au-NPs) [3] and thiol-modified nucleic acid aptamers (Fig. 1b). This work opens the door to the integration of high-quality graphene layers in technological platforms for plasmonics, biosensing or advanced field-effect transistor devices.

References

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[2] Bueno, R.A et al., Nature Communications (2017), 8, 15306; Pat. App. No. P201630971.
[3] Martínez, L.; Scientific Reports, 8 (2018) 7250

Figures

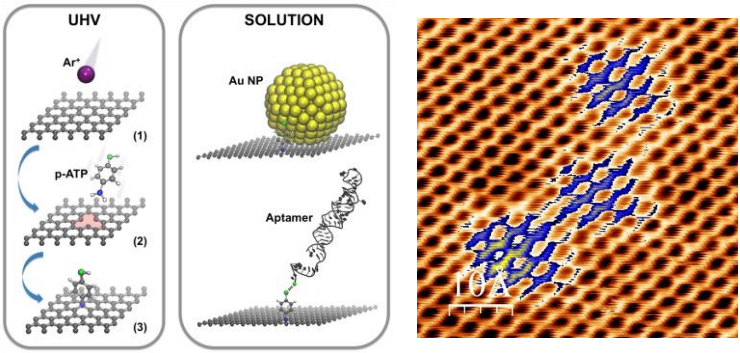

Figure 1: Left: Schematic illustration of the two-step functionalization process. Right: STM image with atomic resolution of graphene functionalized with aminophenol molecules