Departamento de Física de Materiales

SEMINARIO

CHEMISTRY BELOW GRAPHENE:
Decoupling graphene and graphene nanostructures by electrochemical oxidation of metal surfaces

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While high-quality defect-free epitaxial graphene can be efficiently grown on metal substrates, strong interaction with the supporting metal quenches its outstanding properties. Thus, protocols to transfer graphene to insulating substrates are mandatory, and these often severely impair graphene properties by the introduction of structural or chemical defects. Here we describe a simple, fast and easily scalable general methodology to structurally and electronically decouple epitaxial graphene from metal surfaces. A multi-technique characterization of the different steps involved in the process, combined with *ab-initio* calculations, shows that after a controlled electrochemical oxidation process a single-atom thick metal-hydroxide layer intercalates below graphene decoupling it from the metal substrate. The decoupling process takes place without disrupting the morphology and electronic properties of graphene. This electrochemical protocol has been proved to be valid independently of the metal substrate and it can be used not only for graphene but for other graphene nanostructures such as graphene nanoribbons.

Epitaxial graphene was grown in UHV conditions by thermal decomposition of fullerenes and the samples were characterized *in-situ* by STM, LEED and XPS. Subsequent *ex-situ* characterization with AFM and Raman before and after the electrochemical treatment demonstrates the efficiency of the decoupling process. This work suggests that suitably optimized electrochemical treatments may provide viable alternatives to transfer protocols for graphene and other 2D materials on diverse metal surfaces.

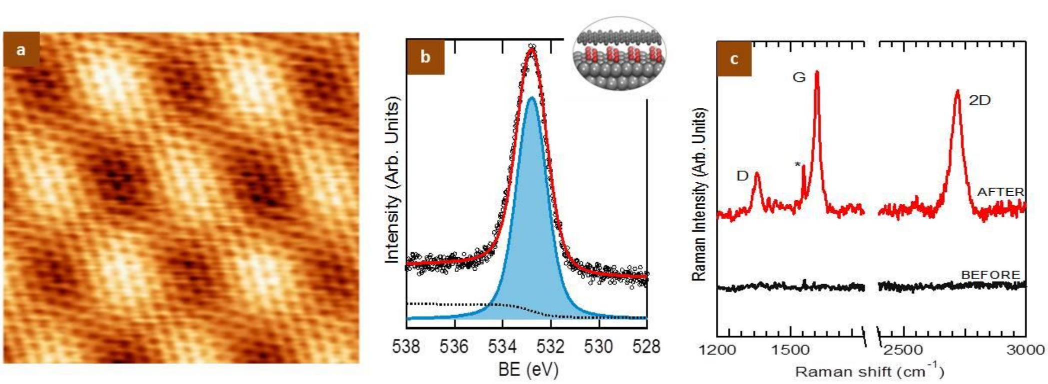

Figure: a) STM image of Gr/Pt(111) showing a characteristic Moiré ((4x4) nm^2, I = 4 nA, V = 10 mV). b) O1s XPS spectrum after the electrochemical treatment and a soft annealing of a Gr/Pt(111) sample. The peak can be fitted with one main component that corresponds to the hydroxide species. Inset: optimized representative Gr/Pt2(OH)@Pt(111) interface with a coverage of 1/2 ML of intercalated-OH between the graphene and the Pt(111) surface. c) Raman spectra of graphene on Pt(111) before (black curve) and after (red curve) electrochemical oxidation. The decoupling of the graphene sheet from the metallic substrate is clear by the emergence of D, G and 2D bands.