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Graphene based platforms for biosensing and enhanced optical imaging

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Abstract

Different approaches to develop graphene based sensors with possible applications for ultra-sensitive detection and quantification of molecules and biomarkers as well as for optical imaging of any 2D or quasi 2D materials are presented.

On one hand, we focuss on enhancing the analyte Raman signal by optimizing and combining different amplification mechanisms. Raman spectroscopy is a non destructive easy to use and specific technique but with low sensitivity. Heterostructures of highly reflecting aluminum and adequate dielectric films have been designed and fabricated to maximize the interference enhanced Raman scattering effect (IERS). Graphene is used as an excellent platform for organic and biomolecules deposition. The combined amplification with that related to localized plasmons of metallic nanoparticles (SERS) is demonstrated. In the same direction, a very interesting IERS amplification platform is that provided by adequately designed ordered porous alumina structures. CVD graphene is transferred on top of the pores so that a continuous flat surface allows the deposition of the analyte. These IERS platforms also provide amplification of fluorescence signals and increase significantly the quality of the optical images for sufficiently thin inorganic or organic samples.

Another approach is based on the covalent functionalization of graphene by adding carboxyl acid groups which allow successive binding with different biologically active molecules for antigen sensing applications. We present a new approach for in-situ specific surface functionalization of graphene which differ from the commonly used graphene oxide derived materials. With this method it is possible to obtain highly conductive COOH functionalized either monolayer or few-layer graphene films. The relative concentrations of defects and functional groups are optimized and the electronic transport characteristics (sheet resistance and mobility) are very adequate for sensing. The bio-molecules detection is carried out by fluorescence images.

Keywords—graphene, metallic nanoparticles, Raman sensing, covalent functionalization

Professional Biography (100-150 words)

Prof. Alicia de Andrés received her PhD in Physics from the Autonomous University of Madrid. Since 2008, she is Research Professor at the Materials Science Institute in Madrid. Leader of the Graphene based hybrid materials group and head of the Optical Spectroscopies Laboratory. She has authored over 160 WOS publications and leaded and participated in projects funded by national, regional and European agencies as well as industrial companies. Her research has focused on the development and study of materials with applications in spintronics and optoelectronics. At present her interest is developing i) graphene based hybrid materials with optimal synergy of organic semiconductors, inorganic nanoparticles and graphene properties for applications as transparent electrodes and as nanostructured active layers in PVs, LEDs, sensors and SERS imaging, ii) materials for lighting and photovoltaics based on rare earth doped nanoparticles and metal organic frameworks as well as metal-organic perovskites.



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