Large-Area 2D-0D Heterostructures via Langmuir-Blodgett Film Deposition

A. Black[1,2]
J. Roberts[3], M. Acebrón[2], R. Bernardo-Gavito[3], G. Alsharif[3], F. J. Urbanos[1], B. H. Juárez[2,4], D. Granados[2], B. J. Robinson[3], A.L. Vázquez de Parga[1,2], R. J. Young[3]
[1]*IMDEA Nanociencia, Madrid, Spain*
[2]*Deparatamento Física de la Materia Condensada*
[3]*Physics Department, Lancaster University, Lancaster, UK*

Contact: andres.black@uam.es

The integration of various low dimensional materials into large area, scalable, heterostructures is highly desirable. For example, 0D semiconducting nanocrystals (NCs) exhibit attractive optical emission and absorption properties, while single layer 2D graphene is ideally suited to act as a transparent electrode due to its superior electrical and mechanical properties.

The integration of silica encapsulated[1], 0D semiconducting NCs with 2D graphene grown by chemical vapor deposition (CVD) is presented in this work. Large area NC films were deposited onto graphene substrates via the Langmuir-Blodgett (LB) method, using a novel electrospray method to successfully spread the NCs[2]. Large area graphene/NC/graphene (Gr/NC/Gr) heterostructures, seen in Figure 1b, were assembled after film deposition. Topographic, mechanical and electrical properties were investigated using scanning probe techniques and scanning electron microscopy. Photoluminescence (PL) and Raman measurements provided complementary optical and spectroscopic information.

By using dimethyl sulfoxide instead of water for spreading the NCs in the LB trough, continuous, homogenous films were obtained which maintained the optical properties of the NCs (Figure 1c). Raman measurements revealed a significant intensity enhancement of the top graphene sheets, along with additional characteristics attributed to the rippling and straining of the top graphene sheet.

References

[1] Acebrón, M et al., App. Materials and Interfaces, 7 (2015) 6935-6945.
[2] Nie, H-L et al., J. Amer. Chem. Soc., 127 (2015) 10683-10688.

Figures

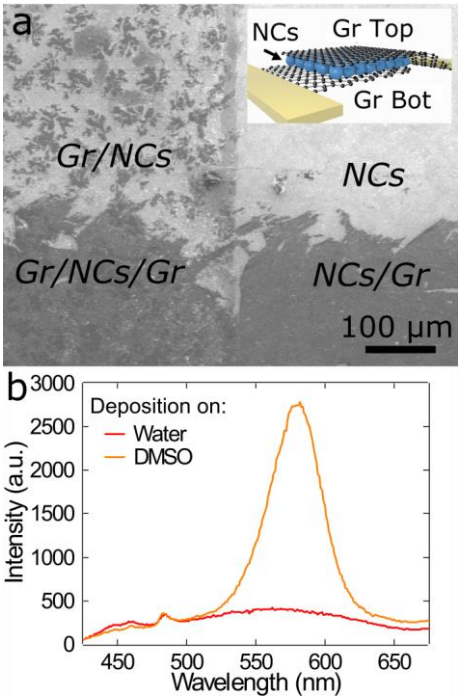

Figure 1: a. SEM images and inset of Gr/NC/Gr heterostructure. b. Ambient PL of Gr/NC/Gr heterostructure, excited at 405 nm.