High Electron Mobility and Low-Field Quantum Hall Effect in Graphene grown on SiC substrates ready for back gating

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Abstract

It seems that we are entering the era of two dimensional materials, that ever since they have been isolated showed amazing potential for developing new devices based on their extraordinary properties. When it comes to industrialization and commercialization, two main issues have to be faced: utilization of reproducible and affordable standardized manufacturing processes and high quality of the final product. For that purpose, we fabricate graphene by selective sublimation of Silicon Carbide (SiC), using an optimized protocol developed in our company. Our typical graphene layers grown on Si face SiC present mobilities in the range of 3000-4000 $cm^2V^{-1}s^{-1}$ at room temperature and up to almost 40000 at low temperature. Furthermore, pursuing the inclusion of graphene in the field of electronics, we produced a novel graphene product grown on top of pre-processed SiC substrates with a buried conducting layer at a depth of 300 nm, formed by ion implantation. By these means, we can provide a substrate where graphene can be easily back gated by biasing the semiconductor buried layer. Our quality inspections, in terms of Raman investigations, revealed that we obtained SiC substrates covered with more than 75% of graphene of superior quality. Moreover, measurements performed on Hall bar devices fabricated along the SiC terraces corroborated those results. That is: mobilities of the electrons as high as 8000 $cm^2V^{-1}s^{-1}$ at low temperature and 2800 $cm^2V^{-1}s^{-1}$ at RT, as well as, low magnetic field plateaux on the Quantum Hall Effect have been observed. Even if these performances are pretty good in this first generation material, the pre-processing of the semiconductor substrate is still impacting the graphene performances and we are working to improve the SiC processing to reach the electrical values obtained on graphene grown on virgin SiC substrates. All those premises make our graphene an ideal candidate to overcome the difficulties in bringing its potential to the desired industrial scale.

Figures

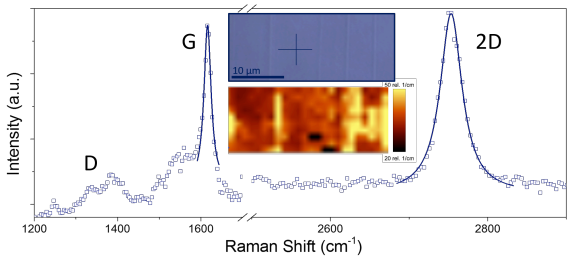

Figure 1: Raman spectra measured at the position indicated by the blue crossin the optical image at the inset. The lower inset figure consists on a maping of the FWHM of the 2D peak, in which only the yellow dots indicate positions where single layer graphene is not found, while all the rest corresponds to the presence of high quality monolayer graphene, as it can be inferred from the color scale to the right.

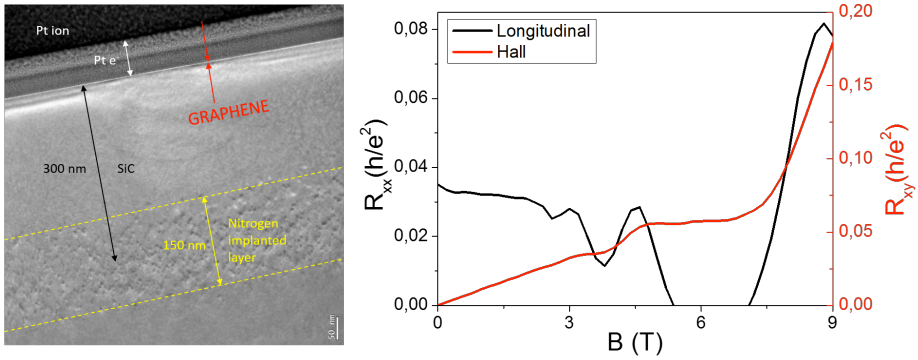

Figure 2: On the left hand side, a HRTEM cross sectional image of a studied sample. The single graphene layer, as well as the conducting buried layer can be observed. On the right side, the results obtained at 2 K for both longitudinal and Hall resistance on the mentioned device.