Surface modification and characterization of carbon-based thin films

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Carbon-based nanomaterials demonstrate physical and chemical properties and exceptional electrical and thermal conduction and stability. In this work the effect of surface modification of graphene and graphene oxide (GO) thin films on the electronic and mechanical parameters was investigated. The graphene surfaces was modified by Ion beam (Ar^+) bombardment with various energies in order to controllable induce defects. The effect of the defects on the adhesion of PMMA/graphene interfaces was studied. Moreover, chemical modification of GO thin films on ITO was investigated. The absolute Work Function (WF) variation with the oxygen content (by thermal reduction of GO) and the heteroatom concentration (nitrogen) was experimentally recorded. The graphitic assemblies were reduced with either thermal (annealing in ultrahigh vacuum (UHV)) or chemical (hydrazine-induced) treatment. Also, a combination of both processes was studied. In the case of thermal reduction, two parameters were studied: (a) the influence of the graphite oxidation protocol and (b) the effect of the GO/rGO film thickness. X-ray photoelectron spectroscopy (XPS), ultraviolet photoelectron spectroscopy (UPS) and Raman Spectroscopy (RS) were used. The surface modification was performed in situ either with Ar^+ ion gun (P_{Ar} = 3×10-6 mbar) with ion energies ranging from 36 up to 200eV or by heating up to 650^{0}C within the XPS instrument. Our analysis revealed that in the case of ion irradiation the density of defects on graphene increases as the irradiation dose increases caused the adhesion improved of graphene/PMMA interface. Additionally, the WF of rGO thin depends on multiple parameters such as the heteroatom concentration, the thickness, the GO flake size, and speciation. It has provided valuable information for designing materials with fine-tuned electronic and chemical properties for the optimization of device performance.

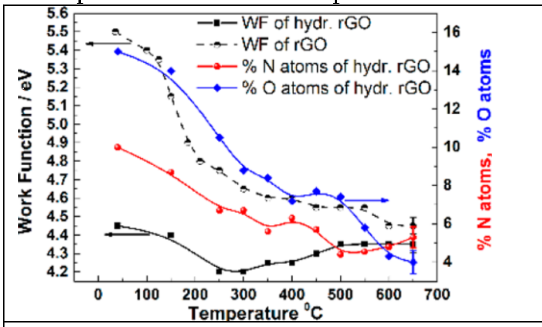

Figure 1: W.F , nitrogen and oxygen atomic concentrations of a 4 nm GO film chemically treated with hydrazine and stepwise heated inUHV. The WF of 4 nm small-flake thermally reduced GO (dashed black line) is shown for comparison.

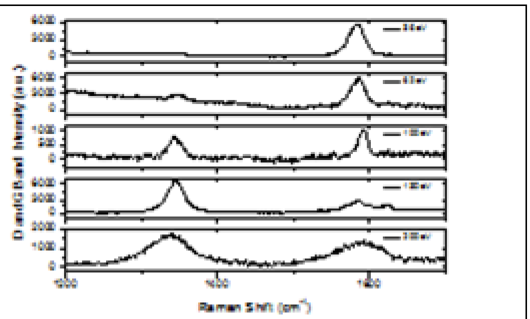

Figure 2: Raman Spectroscopy (λ_{exc}=514.5 nm) for graphene/Cu after 36eV, 65eV, 100eV, 130eV and 200eV Ar^+ bombardment

References

[1] L. Sygellou, G. Paterakis, C. Galiotis, D. Tasis, J. Phys. Chem. C , **120**, 281−290 (2016).

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