Electronic measurements of single-layer graphene functionalized by magnetic nanoparticles

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Graphene is a monolayer of sp^2-bonded carbon atoms tightly packed into a two-dimensional honeycomb lattice. Pristine graphene is intensively studied due to its extraordinary properties, and its various derived forms opens avenues towards new fields of research [1]. While graphene is nonmagnetic in itself, experimental observations show that magnetism can be induced by introduction of impurities, boundaries or defects [2]. The properties of graphene can also be modified by doping, chemical functionalization or decoration by nanoparticles (NPs). Magnetic NPs have interesting properties, which are dependent on their size. In this work, we are interested in chemical functionalization to decorate graphene with magnetic NPs, and in particular with magnetite (Fe_3O_4). The electronic and transport properties of modified graphene are evaluated thanks to local measurements using AFM-derived techniques. In this context, the chosen functionalization is a very attractive method because it offers the possibility to decorate graphene without disturbing its crystalline network.
The magnetite NPs were synthesized by thermal decomposition of iron acetylacetonate, $Fe(acac)_3$ [3]. The adsorption of oleylamine at the surface of the iron oxide leads to the formation of well-formed and separated NPs of 7-10 nm of diameter (Figure 1). The particles were dispersed in hexane and characterized by HR-TEM, EDX and SEM. In parallel, single-layer graphene was prepared and transferred on SiO_2/Si chips. The CVD graphene devices were then functionalized by drop casting of the suspension of NPs. The device is rinsed with isopropanol and acetone to remove the excess of NPs. SEM and XPS analyses allowed us to confirm the presence of magnetite on the surface of graphene and to evaluate its coverage. The transport measurements are performed to investigate the influence of the particles on the properties of graphene. The Dirac point position and the mobility are compared between pristine and functionalized graphene.

References

[1] V. Georgakilas, M. Otyepka, A. B. Bourlinos, V. Chandra, N. Kim, K. Ch. Kemp, P. Hobza, R. Zboril, K. S. Kim, Chem. Rev. 112 (2012) 6156.
[2] R. Nair et al., Nature Phys. 8 (2012)199.
[3] Z. Xu, C. Shen, Y. Hou, H. Gao, S. Sun, Chem. Mater. 21 (2009) 1778

Figures

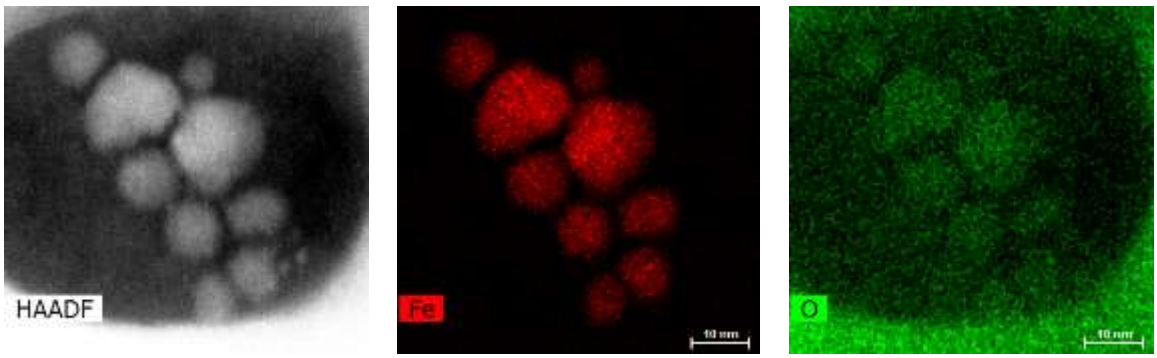

Figure 1: STEM-EDX images of magnetite nanoparticles (Fe_3O_4)