

Interface coupling in graphene/ferroic hybrid structures

Zied Othmen^{a,b}, Kais Daoudi^b, Michel Boudard^c, Antonella Cavanna^d, Pascale Gemeiner^a, Meherzi Oueslati^b, Brahim Dkhil^a, Ali Madouri^d, Claire Mathieu^e

^a Laboratoire Structures, Propriétés et Modélisation des Solides, Centrale Supélec, CNRS-UMR 8580, Université Paris-Saclay, 92290 Châtenay-Malabry France

^b Unité Nanomatériaux et Photonique, Faculté des Sciences de Tunis, Université de Tunis El Manar, 2092, Tunis, Tunisie ^cUniv. Grenoble Alpes, CNRS, LMGP, F-38000 Grenoble, France

^dCNRS/C2N, Route de Nozay, F-91460 Marcoussis, France

^eSPEC, CEA, CNRS, Université Paris-Saclay, CEA Saclay, 91191 Gif sur Yvette cedex, France

* zied.othmen@centralesupelec.fr

Recently, hybrid structures made of graphene and ferroic oxides have received numerous attention for their potential applications in various fields including electronics, photonics and optoelectronics [1]. The physical properties of ferroic oxides arise from competition between spin, charge, orbital, polar and/or lattice degree of freedom [2]. Growing graphene (Gr) (zero bandgap semiconductor with high electron and hole mobility, unusual diamagnetism, ...) layer on top of such materials may thus give rise to a wide variety of proximity phenomena with interesting implications for fundamental science and device concepts. Here, we selected two representative ferroic oxides namely the cobaltite $\text{La}_{0.7}\text{Sr}_{0.3}\text{CoO}_3$ (LSCO) and the titanate BaTiO_3 (BTO) systems characterized by ferromagnetic and ferroelectric order parameter, respectively. We combined several techniques to investigate the consequences on the properties of both ferroic and graphene components in Gr/LSCO and Gr/BTO heterostructures. We show for instance using Raman spectroscopy that Jahn-Teller active Raman modes related to oxygen octahedral distortions are induced in the Gr/LSCO (20 nm) nanostructure which drastically differs to the situation of LSCO (20 nm) without graphene. This observation is attributed to a charge transfer from graphene to LSCO promoting the intermediate spin states of $\text{Co}^{3+/4+}$. The electronic and magnetic structures are also affected in Gr/LSCO structure [Z. Othmen et al., to be published]. Graphene properties are also changed as for instance in case of Gr/BTO heterostructure where the so-called 2D graphene Raman mode changes its behavior as a function of temperature concomitantly to ferroelectric phase transitions of BTO [Z. Othmen et al., to be published]. These results show how the ferroic properties can be affected/tuned by the graphene layer and conversely.

[1] Uang-Xin Ni et al., ACS Nano, 2012, 6 (5), pp 3935–3942

[2] A. Podlesnyak et al., Phys. Rev. Lett. 97, 247208 (2006)