Interface coupling in graphene/ferroic hybrid structures

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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 La\textsubscript{0.7}Sr\textsubscript{0.3}CoO\textsubscript{3} (LSCO) and the titanate BaTiO\textsubscript{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 Co\textsuperscript{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.