Templating effects of graphene in stabilizing ultrathin compounds on metals

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Abstract:

Ultrathin oxide films grown on metallic substrates have been intensively investigated in modern surface science [1,2]. A convenient way to tailor the physical and chemical properties of oxide/metal interfaces is the use of a buffer layer, i.e. an ultrathin metallic or oxide film interposed between the substrate and the overlayer. In some of our recent investigations, we have shown that the morphology and electronic properties of oxide films can be tuned by using a buffer layer of graphene stabilized on the Ni(111) surface [3]. High quality graphene layers can, in fact, be successfully grown on the close-packed surfaces of many transition metals [4].

A common strategy to perform a well-controlled growth of thin transition metal oxides, is the reactive deposition of transition metals in an oxygen atmosphere. We have investigated, in this respect, the templating effects of graphene/metal surfaces in stabilizing such low-dimensional compounds. In particular, we have been growing Chromium and Fe oxides on the graphene-covered and graphene-free Ni(111) surfaces and Chromium oxide on the graphene-covered and graphene-free Pt(111) surface.

Considering first the Ni(111) substrate, dramatically different results are obtained for the growth of Cr and Fe oxides. In the former case, an ordered Cr_2O_3 ultrathin overlayer can be obtained, showing that graphene can act as an ideal buffer layer for the growth of high-quality oxide layers [3]. In the latter case, the presence of graphene induces the switching from a 2D to a 3D growth of FeO_x [5], suggesting an effective strategy to maximize the possible catalytic effects of an ultrathin oxide.

Coming to Pt(111), here a multidomain graphene layer could be obtained. Despite this, we were able to show that Cr_2O_3 ultrathin films grown on graphene/Pt(111) maintain their stoichiometric and electronic properties mostly unaltered, compared to Cr_2O_3 on bare Pt(111). On the other hand, a 3D growth scenario is observed for Cr_2O_3 on graphene/Pt(111), and a 2D layer-by-layer growth is observed on bare Pt(111), oppositely with respect to the Cr_2O_3/Ni(111) case and more similarly to the FeO_x/Ni(111) case [6].

I will finally be discussing potential applications of these ultrathin oxides for spintronics applications, making reference also to other classes of hybrid interfaces involving magnetic transition metal oxides and molecular materials [7].

Keywords: transition metal oxides,.graphene, surfaces and interfaces, ultrathin films, metal-oxide interfaces, spintronics.

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