Electronic and magnetic properties at the metal-organic interface

The electronic and magnetic properties of organic compounds are in most cases strongly modified by the presence of a metallic interface [1]. The subtle correlation between these properties and the bonding configuration at the interface is in fact responsible for the lack of reproducibility in the transport properties of molecular junctions, in particular when the latter consists on a single layer or, at the limit, a single molecule [2]. The STM presents an ideal tool to correlate conformational and spectroscopic properties at the atomic scale. Here I will present two different cases where the properties of the organic compound are strongly modified by the metallic substrate: single metal-organic molecules adsorbed on Ag(100) and graphene nanoclusters on Ni(111).

In the case of single metal-phthalocyanines, we see that, depending on the metal ion hosted by the molecule, the interaction with the substrate can either quench or enhance the magnetic properties [3]. In the latter case, we observe induced spins at the ligand coexisting with that at the central transition metal ion, which can be probed by the Kondo effect [4]. The ion-ligand intramolecular exchange interaction leads to magnetic excitations that appear at the dI/dV spectra. The charge and spin of the metal ion and ligand can be selectively manipulated by doping molecules atom by atom with alkali dopants [5]. The charge redistribution at the interface is dominated by the presence of the metallic reservoir, which can act either as electron donor and acceptor, or as mediator of long-range Coulomb interactions. As a result the doping behaviour is fundamentally different from that found in organic films [6].

In the case of graphene nanoclusters, we exploit the interaction with the metallic substrate in order to engineer the Dirac bands and obtain graphene interfaces with different functionalities. I will focus on the particular case of Ni(111), where the interaction with the metallic surface opens a gap and spin-polarizes the Dirac bands [7], which results in a spin filtering effect in the transport across the interface. On the other hand, the hexagonal and triangular islands with atomically precise edges [8] allow us to study the lateral transport across the nanoislands. The standing wave patterns created around the nanoislands reveal an asymmetric potential that depends both on the spin and edge type, suggesting a lateral 2D spin-filter effect similar to that occurring across the interface.

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