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Magnetism of single impurities at surfaces

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Artificial heterostructures consisting of thin films and small clusters down to single atoms, deposited in a controlled way on surfaces or embedded in a substrate are model systems to investigate the origin of the magnetic anisotropy energy (MAE) and magnetic interactions. In particular, we want to find which combination of magnetic atom and substrate results in the highest MAE.
Good candidates are very small Co clusters on graphene and benzene. Recent theoretical calculations predicted an MAE of a few tens of meV for the Co monomer on graphene and even larger values of about 300 meV for the Co dimer adsorbed on benzene [1, 2]. However, these predictions are only for pure freestanding graphene, thus it is reasonable to imagine that the interaction of graphene with the supporting substrate is a key parameter. Graphene is strongly hybridized with the d valence bands of Ru(0001) and Rh(111) while the bonding is mostly of van der Waals character on Ir(111) and Pt(111) [3, 4].
In order to check these predictions, we deposited Co single atoms, dimers and larger clusters on Ru(0001) and Ir(111), used as model substrates for the case of strong and weak hybridized graphene, respectively. Strong differences are observed as a function of the cluster size and the degree of hybridization between graphene and substrate.
The experiments has been performed at the at the X-Treme beam line of the Swiss Light Source. This beam line gives the unique opportunity of combining in a single UHV chamber a low temperature (2K) high magnetic field (7T) cryostat for XAS-XMD, a chamber for sample cleaning and in-situ MBE growth [5], and a variable temperature STM (scanning tunneling microscope) fundamental to check the quality of the in-situ grown graphene.

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