iLM
INSTITUT LUMIÈRE MATIÈRE

"Magnetic Nanostructures" group

Master 2 research internship / PhD research subject

Self-organization of preformed magnetic nanoparticles deposited on template surfaces

Growing identical and organized nanostructures on a surface is of great interest both for applied and fundamental physics. In particular, the realization of arrays of magnetic nanoparticles on surfaces opens new perspectives for magnetism, catalysis, or optics. In that view, the use of spontaneously pre-patterned substrates at the nanometer scale is a promising way to induce the nucleation and growth of nanoparticles on specific sites.

Previously, physical approaches based on atomic deposition have not only leaded to regular network of clusters, but also to narrow particle size distributions with well-defined properties. Growth of Co clusters on the Au(111) reconstructions and on vicinal gold surfaces [Au(788) and Au(677) for instance] are some of the most famous examples. Another template used for nanoparticle self-organization is graphene epitaxially grown on Ir(111), where the surface develops a 2.5 nm hexagonal moiré superlattice.

Very recently, we have shown that the deposition of size-selected preformed clusters can also lead to self-organization of nanoparticles on graphene/Ir(111). This approach appears complementary and even able to overcome some difficulties inherent to atomic deposition: the coverage can be fully controlled (without changing the particle size), the 3D nature of the deposited particles allows larger sizes, and alloy particles of well-defined composition and size can be directly deposited. Concerning gold surfaces, pure palladium clusters have been recently shown to self-organize on Au(111) but the deposition of bi-metallic preformed clusters on such surfaces (and vicinal surfaces) has still not been explored. Depositing size-selected preformed magnetic clusters on pre-patterned surfaces thus appears very promising, especially for particles such as CoPt or FePt which are of great magnetic interest.

We aim at studying the organization and properties of assemblies of preformed magnetic nanoparticles deposited on template surfaces. These features are of prime importance in view of a better understanding of cluster-surface interactions, to infer the role of the nanoparticles/substrate interface on their magnetic anisotropy for instance and also in view of studying collective magnetic states in nanoparticle arrays. This study will involve several experimental techniques, from nanoparticle sample preparation using laser vaporization and ultra-high vacuum deposition, to advanced characterizations using synchrotron experiments (x-ray scattering), but also scanning tunnelling microscopy (STM) and magnetic measurements. The student should have a good background in solid state physics, surface science or nano-science in general.

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