Self-organization of preformed magnetic nanoparticles deposited on gold surfaces

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Scientific Context :  
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 can be an efficient way to induce the nucleation and growth of nanoparticles on particular sites. It has been recently shown that depositing size-selected preformed magnetic clusters on such specific surfaces is very promising, especially for particles such as CoPt or FePt which are of great magnetic interest. This original approach appears complementary and even able to overcome some difficulties inherent to atomic deposition: arrays of well-defined bimetallic nanoparticles are indeed difficult to achieve by conventional techniques.

Missions :  
We aim at studying the organization and properties of assemblies of preformed magnetic nanoparticles deposited on nanostructured gold surfaces (reconstructed and vicinal 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. More precisely, we want to investigate the organization and to determine the surface pinning sites (steps, kinks..) of preformed size selected FePt nanoparticles soft-landed on both Au (111) and Au (677) surfaces. The evolution of the system (organization, cluster coalescence...) with post annealing processes (required to obtain chemically ordered FePt nanomagnets) will also be studied. According to previous results based on cluster deposition on surfaces (CoPt on graphite and gold, Pt and FePt on graphene, Pd on gold) that reveal the extreme sensitivity of preformed clusters to atomic defects or superstructures, we should be able to obtain organized networks of size selected FePt alloy clusters.

Outlooks :  
This study will involve several experimental techniques, from surface preparation and characterization, as well as nanoparticle sample preparation using laser vaporization and ultra-high vacuum deposition, to scanning tunnelling microscopy (STM) measurements and advanced characterizations using synchrotron experiments (x-ray scattering and absorption). The student should have a good background in solid state physics, surface science or nano-science in general.

Depending on the funding possibilities, this research activity can be continued for a 3-year PhD.