O 12: Nanostructures at surfaces: Dots, particles, clusters I (magnetic)

Time: Monday 15:00–16:30 Location: SCH A215

O 12.1 Mon 15:00 SCH A215

Correlation of shape and magnetic anisotropy of mass-filtered Fe and FeCo alloy nanoparticles supported by W(110) — Armin Kleibert[1], •Furkan Bulut[2], Kerstin Gebhardt[3], Wolfgang Rosellen[3], Daniela Sudfeld[4], Johannes Passig[1], Joachim Bansmann[2], Karl-Heinz Meiwes-Broer[1], and Mathias Getzlaff[3] — [1]Institut für Physik, Universität Rostock, Germany — [2]Institut für Oberflächenchemie und Katalyse, Universität Ulm, Germany — [3]Institut für Angewandte Physik, Universität Düsseldorf, Germany — [4]Institut für Experimentalphysik, Universität Duisburg-Essen, Germany

Magnetic clusters and nanoparticles are promising candidates for many future applications. Understanding and controlling their magnetic anisotropy energy (MAE) is important, particularly when attempting, e.g., to overcome the so-called superparamagnetic limit in high density storage devices. In the present work we study shape and interface related contributions to the MAE of supported nanoparticles. For this purpose mass-filtered Fe and FeCo nanoparticles have been deposited onto a bare W(110) surface. The structure and shape of the nanoparticles were determined by *ex situ* high resolution transmission electron microscopy. *In situ* scanning tunneling microscopy yields evidence for a partial flattening of the supported particles. Magnetization curves reveal a magnetic hard axis perpendicular to the surface. The observed MAE is compared to model calculations on shape and interface anisotropy contributions of flattened nanoparticles.[1]

[1] A. Kleibert *et al.*, J. Phys.: Condens. Matter **20**, 445005 (2008).

O 12.2 Mon 15:15 SCH A215

Ultra-high dense array of magnetic quantum dots on a self-assembled nanostructured template — •Laura Fernández[1], Martina Corso[2], Maxim Ilyn[3], Frederik Schiller[4], and José Enrique Ortega[1,2,4] — [1]Departamento de Física Aplicada I, Universidad del País Vasco, San Sebastián, Spain — [2]DIPC, San Sebastián, Spain — [3]Física de Materiales, Universidad del País Vasco, San Sebastián, Spain — [4]Unidad de Física de Materiales, Centro Mixto CSIC-UPV/EHU, San Sebastián, Spain

The growth of magnetic nanoparticles on surfaces by auto-organization processes represents a flexible and powerful alternative to obtain high-density, patterned magnetic storage media. Here, we report on the growth of a dense array of Co quantum dots on a previously designed template formed by a Moiré surface structure, which allows the achievement of dot areal densities that overcome the boundary of 1 Teradots/inch^2. The structural properties of the template and the tunability of the quantum dot array have been thoroughly explored by Scanning Tunnelling Microscopy at several deposition temperatures and different Co coverage. The magnetic response of the Co quantum dots has been investigated by vibrating sample magnetometry, showing an uniaxial out-of-plane anisotropy and soft magnetic behaviour at 300 K.

O 12.3 Mon 15:30 SCH A215

Ferromagnetism of magnetic nanodot ensembles promoted by substrate-mediated interaction — •Pavel A. Ignatiev[1], Nikolay N. Negulyaev[2], Alexey S. Smirnov[3], Larissa Niebergal[1], Alexander M. Saletsky[3], and Valeri S. Stepanyuk[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany — [2]Physics Department, Martin-Luther-University Halle-Wittenberg, 06099 Halle, Germany — [3]Faculty of Physics, Moscow State University, 119899 Moscow, Russia

Recent experimental studies evidenced collective ferromagnetic behavior with high Curie temperatures in Fe nanodots assemblies created on Cu(111) surfaces by means of buffer layer assisted growth [1,2]. It was suggested that a substrate-mediated indirect RKKY-like exchange interaction between Fe dots was responsible for the magnetic order [2].

Here we present combined ab initio and kinetic Monte Carlo (kMC) investigations of the magnetic ordering in ensembles of Fe nanodots embedded in noble metal (Cu, Ag, Au) substrates. Exchange interactions in considered systems are calculated fully ab initio by means of the Korringa-Kohn-Rostoker Green's function method. kMC simulations based on this ab initio input revealed the ferromagnetic ordering in the ensemble of Fe nanodots.

[1] J. P. Pierce et al., Phys. Rev. Lett. 92, 237201 (2004).
[2] M. A. Torija et al., Phys. Rev. Lett. 95, 257203 (2005).

O 12.4 Mon 15:45 SCH A215

Structural and Magnetic Properties of Fe and Co Clusters on Alumina/Ni_3Al(111) — •Andreas Buchsbaum[1], Maurizio De Santis[3], Helio Tolentino[3], Georg Kresse[2], Michael Schmid[1], and Peter Varga[1] — [1]Inst. f. Allg. Physik, TU Wien, Austria — [2]Faculty of Physics, CMS, University of Vienna, Austria — [3]Institute Neel, CNRS Grenoble, France

The structure of the $\approx$ 5 Å thick aluminum oxide on Ni_3Al(111), which has been solved recently, exhibits holes at the corner of the $(\sqrt{67} \times \sqrt{67})R12.2°$ unit cell, reaching down to the metal substrate [1]. Therefore, the ultrathin oxide film, forming a nanomesh with a 4.1 nm lattice, is a perfect template for growing highly regular arranged metal clusters. Pd atoms trapped in the corner holes, create metallic nucleation sites, where Fe as well as Co clusters can nucleate and form a well-ordered hexagonal arrangement on the oxide nanomesh [1]. We have studied the morphology of the Fe and Co clusters and applied different methods to determine the orientation of the clusters. For Fe we found cluster growth in either bcc[110] or bcc[100] direction, depending on the deposition temperature and for Co we found close-packed planes on top of the clusters and random stacking of fcc and hcp planes. As the cluster size is limited to $<$ 4 nm, pure Fe and Co clusters are superparamagnetic at temperatures where the Ni_3Al substrate is paramagnetic, i.e., the blocking temperature T_B of the clusters is below the Curie temperature of the substrate T_C. For ferromagnetic clusters, materials with higher anisotropy are required.

[1] M. Schmid et. al., Phys. Rev. Lett. 99, 196104 (2007).

O 12.5 Mon 16:00 SCH A215

Probing the Magnetism of Nanostructures buried in Metallic Surfaces: an *Ab-Initio* Study — •Oleg O. Brovko and Valeri S. Stepanyuk — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

For a long time it has been known, that the apparent transparency of metallic surfaces for electronic states can be utilized to detect and study buried nanostructures. We show that it is as well possible to study the magnetic properties of nanostructures buried up to 20Å deep in metallic surfaces. Our *ab-initio* calculations reveal the possibility of detecting magnetic properties of 3d atoms and small clusters embedded into a metallic surface and even determining the magnetic coupling between them.

O 12.6 Mon 16:15 SCH A215

Utilizing the Quantum Confinement on Islands for Exchange Interaction Tailoring: an *Ab-Initio* Study — •Oleg O. Brovko and Valeri S. Stepanyuk — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Vacuum barriers at island borders inevitably confine the surface electrons to the island's geometry. Electron density redistribution which arises from such a confinement can have a substantial effect on the magnetic interaction of impurities adsorbed on top of the island. Our *ab-initio* calculations for 3d adatoms adsorbed on islands clearly demonstrate that by varying the island's size it is possible to tailor the surface-state-mediated exchange interactions of adatoms at separations ranging from several angstroms to several nanometers. By deliberate choice of the islands size the exchange coupling can be enhanced, weakened or even reversed.