PREPARATION AND CHARACTERIZATION OF SELF-ORGANIZED ARRAYS OF MAGNETIC QUANTUM DOTS ON SEMICONDUCTOR SUBSTRATE

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Highly ordered arrays of magnetic nanodots can be prepared in an efficient way by making use of either preferential nucleation or grazing-incidence shadow deposition onto patterned substrates, highly ordered arrays of magnetic nanodots can be prepared in an efficient way [1]. We have deposited Co in ultra-high vacuum onto self-organized templates consisting of SiGe alloy films epitaxially grown onto single-crystal Si(001) wafers, presenting checkerboard arrays of pyramids with {105} facets [2]. These surface patterns develop spontaneously as a result of misfit strain relief; their size, shape and arrangement can be tailored by controlling growth parameters such as Ge concentration, film thickness or substrate temperature. The Co films have been imaged *in-situ* by Low-Energy Electron Microscopy (LEEM) and X-ray Photoemission Electron Microscopy (XPEEM) with X-ray Magnetic Circular Dichroism (XMCD) at the Nanospectroscopy Beamline of synchrotron Elettra. Further *ex-situ* characterization of the samples' surface morphology and magnetic behavior has been achieved by means of Atomic Force Microscopy (AFM) and Magneto-Optic Kerr Effect (MOKE), respectively.

Co nanodots grown by grazing-incidence evaporation onto the bare semiconductor surface can be observed in Fig. 1. Their lateral sizes can be as small as 200 nm x 25 nm, depending on the substrate. Their size and spatial distribution is dictated by the substrate template. The dots are ferromagnetic and single-domain at room temperature; they display uniaxial magnetic anisotropy caused by the off-normal deposition. Domains composed of various dots are observed, indicating that the individual magnetic nanoparticles are coupled through their dipolar interaction [3]. The dots' magnetic behavior is analyzed with the help of micromagnetic simulations and calculations of interdot coupling.

Our approach to overcome the coupling of the magnetic nanodots is to substitute the Co for other materials or combinations such as multilayers with enhanced magnetic anisotropy (shape, crystalline or surface) and a stronger coercivity, to ensure that the magnetic status of one particle cannot be reversed by the interaction with its neighbors. For this purpose, we have started to study the preparation of short-period (2-3 nm) {Co/Au} and {Co/Pt}

multilayers onto these self-organised semiconductor substrates. Besides their higher magnetic hardness, these multilayers exhibit perpendicular magnetization, which makes them advantageous candidates for magnetic recording media due to the increased signal-to-noise ratio for readout. The first, tentative results along this line are presented and discussed.

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References:

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Figures:

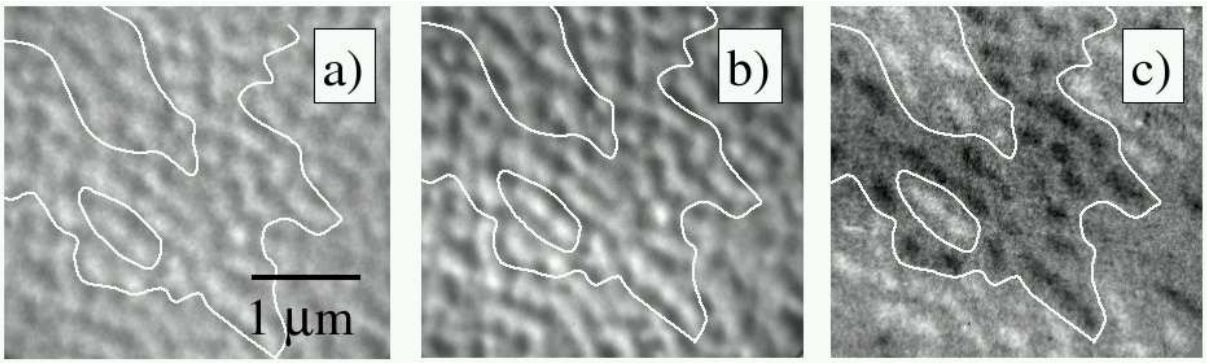

Figure 1: (a) Low Energy Electron Microscopy (LEEM), (b) X-Ray Photoemission Electron Microscopy (XPEEM) and (c) XPEEM with X-Ray Magnetic Circular Dichroism (XMCD) images of a 6.5 ML Co layer deposited at room temperature and grazing incidence. The LEEM image is only sensitive to the surface topography while the XPEEM image shows that the spatial distribution of the deposited Co follows the surface template. Finally, XMCD provides magnetic contrast and reveals that the dots are ferromagnetic at room temperature and coupled forming micrometer-sized domains.