

Keywords: thin-film epitaxy, RHEED, MBE

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Thermally induced structural transformation in Co films for giant magnetoresistance spin valves

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The contribution is devoted to correlation between structural and magnetic properties of cobalt thin films exposed to vacuum annealing which are applied in giant magnetoresistance spin valves with current induced magnetization switching developed in our laboratory. The films of 40-130 nm thicknesses were deposited by electron beam evaporation onto Si wafers and treated by rapid thermal annealing up to 600°C. Thickness, surface/interface roughness and density profile of the films were determined by X-ray reflectivity. X-ray diffraction was measured in symmetrical reflection and grazing incidence geometries. As-prepared films exhibit modified near-surface region and roughness of 1 nm which was more than doubled on 600°C/1hour annealing. The film thickness decreased by 2-3% and the density increased accordingly. These changes are presumably connected with structural transformation observed in the films which was studied in detail on the 40 nm thick sample. The starting structure showed one broad diffraction peak around 44.5 degrees with a shoulder on the low-angle side which could be fitted as overlap of 100 and 002 diffractions of hexagonal close-packed (hcp) Co phase with the grain size of 14 nm. A similar analysis on a series of annealed samples revealed a transformation into (111) textured face-centered cubic (fcc) phase starting at 300°C which was completed on 600°C/1hour annealing with the grain size of 30 nm. This phase remained stable at room temperature. Longitudinal magneto-optical Kerr effect measurements showed enhancement of coercivity by a factor of two and loss of its azimuthal dependence which is in line with more degrees of freedom for spin reorientation in fcc structure. In thicker Co films, hcp and fcc phases coexist already in the as-deposited state.

Keywords: magnetic film, rapid thermal processing, structural transformations

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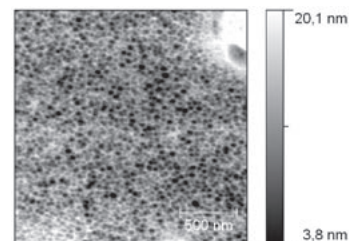
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Gas deposition growth of ytterbium nanoparticles

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Formation of lanthanides' nanoparticles has become significant in basic research as well as some application to nanotechnology. Ytterbium is one of the most interesting elements in lanthanide because of its unique physical and chemical properties. In the present study, the gas deposition method has been employed to prepare the particles with wide variety of sizes. Metallic ytterbium has been evaporated by heating (300~650°C, melting point is 824°C) in He environment (0.5~11 Pa). The particles are formed by solidification

and aggregation during the collisions with He gas molecules. A glass substrate, of which backside is water-cooled, is put at close position (~10mm) from the top of the K-cell, to collect floating particles. Figure 1 shows a typical AFM image of the ytterbium particles (0.49 Pa, 400°C, 1 hour deposition). The shape of particles is almost spherical with relatively narrow size distribution. Particles are randomly spread on the substrate without any preferred organization. Grazing incidence X-ray techniques were used to determine the structures. In the present study, the use of N₂ gas has been also attempted. The comparison will be discussed in the presentation.



Keywords: nanoparticles, X-ray characterization, AFM

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Highly spin-polarized interfaces between a half-metallic Heusler alloy and silicon

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Finding out ferromagnet/semiconductor interfaces which show high spin polarization at the Fermi energy is one of the key issues for achieving efficient spin injection into semiconductor. First-principles calculations have so far proposed many ferromagnets completely spin-polarized at the Fermi energy (half metals). However, it is also pointed out from theory that those half metals rarely keep the high spin polarization at interface. Regarding half-metal/Si heterostructures, for example, no highly spin-polarized interface has been predicted, though spin injection into Si is of great importance for developing silicon-based spintronics devices. In this work, we have investigated the electronic and structural properties chiefly of Co₂FeSi/Si and CoFeSi/Si interfaces using first-principles density-functional calculations. The half-metallic properties possessed by both Co₂FeSi and CoFeSi in the bulk state are found to be almost preserved at specific (110) interfaces. Besides, these highly spin-polarized interfaces turn out to have the lowest energy of the (110) interfacial patterns studied here. The nearly half-metallic character at the interfaces is also found in the densities of states projected onto delocalized sp-orbitals; this fact suggests that the high spin polarization is closely related to transport properties and, accordingly, to spin injection into Si. Possibility of similar interfacial half-metallicity will be further discussed for other heterostructures consisting of a Heusler alloy and a group IV semiconductor.

Keywords: half metal, spintronics, *ab-initio* calculations

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In-situ XRD study of thickness dependence of crystallization of amorphous titanium dioxide films

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