MAPPING THE SPIN PHASE DIAGRAM OF METASTABLE MAGNETIC ULTRATHIN FILMS

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Several ultrathin magnetic film systems exhibit a reorientation of magnetization as the film thickness is increased beyond some critical value. In some metastable systems, purely thickness driven spin reorientation is unfortunately masked by structural transitions. We present a method in which the magneto-optic Kerr effect (MOKE) can be used to uncover the "true" critical thickness (the transition thickness in the absence of structural changes) and anisotropy constants of a metastable film as a function of temperature. We demonstrate this method on the face-centered tetragonal (fct) Fe/Cu(100) system, which undergoes a structural transition to a face-centered cubic (fcc) phase at a thickness of 4 ML.

Under ultrahigh vacuum and at given temperatures, we evaporated small fractions of a monolayer of Co on fct Fe/Cu(100) films of various thicknesses. For each Fe film, we determined the thickness of cobalt necessary to reorient the magnetization from the direction perpendicular to the film to the in-plane direction. Those experiments yielded a plot of Co critical thickness vs. Fe thickness at each temperature. The x intercept of these plots, the Fe thickness at which the spin would reorient without a Co capping layer, was taken to be the critical thickness for the fct Fe film. Our data directly result in a magnetic phase diagram for fct Fe films, which maps the magnetic state (magnetization perpendicular, or in-plane) in the space of temperature and Fe thickness.

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