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Complementarity of PNR and XMCD for monolayer-magnetism in hetero-epitaxial Fe on Cu(001)

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We have combined two complementary techniques, element sensitive ex situ X-ray magnetic circular dichroism (XMCD) and in situ polarized neutron reflectivity (i-PNR), to determine the values of evolving magnetic moments obtained from a low symmetry system of hetero-epitaxial Fe monolayers (MLs), as a function of thickness. The samples were grown by magnetron sputtering on face-centered-cubic (fcc) Cu(001)/Si(001). Within experimental errors, we found a corroboration of the modulated moments from the XMCD and of the magnetic anisotropies from magnetization measurements with those obtained earlier from layer-by-layer i-PNR measurements. Furthermore, analyzing the depth sensitive i-PNR profile of a bulk-like film, we developed a model characterized by monotonic magnetism involving collinear spins. The results have been compared with those existing, following the theoretical parameterized tight-binding model with satisfactory agreement. This study distinguishes the variation of monolayer-magnetism owing to the growth morphology from the layer-by-layer investigation vis-à-vis depth-profiling of bulk-like film. At the same time, it also promises the general possibility of depth-profiling using i-PNR in other complex multilayered systems on high flux neutron sources.

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