THE ROLE OF INTERFACE ROUGHNESS IN THE MAGNETIC COUPLING OF SINGLE-CRYSTALLINE ULTRATHIN ANTIFERROMAGNETIC/FERROMAGNETIC BILAYERS

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Despite the recent interest in the coupling between an antiferromagnetic and a ferromagnetic film, fueled by applications in magnetoresistive devices, a full understanding of the observed phenomena is still elusive. This is in part due to the incomplete characterization of the interface in the sputtered polycrystalline bilayers that are typically used. In order to address this issue, we deposited epitaxial fcc Co-FeMn and Ni-FeMn bilayers on a Cu(001) single crystal surface by electron beam assisted thermal evaporation. Oscillations in the diffracted electron intensity during growth of the bilayers as well as scanning tunneling microscopy studies indicate layer-by-layer growth. The magnetic domain configuration was studied by photoelectron emission microscopy (PEEM) in combination with magnetic circular dichroism in soft x-ray absorption. Characteristic changes in the domain pattern of the Co layer are observed at the transition of the FeMn layer between paramagnetic and antiferromagnetic as a function of FeMn thickness or temperature. These include a drastic reduction in domain size of the as-grown bilayers, and a change in the magnetization direction from <110> to <100> in-plane directions. This is discussed as being due to monoatomic steps at the interface which lead to magnetic frustrations at topological 90° domains in the antiferromagnetic FeMn layer if one assumes the non-collinear spin structure of bulk FeMn. Measurements of the linear magnetic dichroism in soft x-ray absorption provide indeed evidence for such a non-collinear spin structure in the FeMn layer. Coercivity oscillations as a function of FeMn thickness with atomic monolayer period are related to step density oscillations present in layer-by-layer growth, and emphasize the importance of step-induced topological domains for the coupling.