Interfacial Order-Parameter Profiles in Critical FeCo Films

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Thin binary alloy films such as FeCo can be regarded as model systems for continuous phase transitions belonging to the Ising universality class. The order-parameter of this phase transition is the sublattice occupation, which is directly accessible through x-ray diffraction techniques. In films having thicknesses comparable to the correlation length of critical fluctuations near the critical point, two competing phenomena are expected to occur: finite-size scaling and the action of wall-forces (surface fields).

We present order-parameter profiles in a temperature window near the critical point of a FeCo thin film epitaxially grown on MgO. Exploiting multiple beam x-ray diffraction techniques, we determine the temperature dependence of those profiles in a phase-sensitive and non-destructive way. A careful lineshape analysis reveals the adsorption of critical fluctuations at the film-substrate interface, which can be interpreted as caused by a surface field. Furthermore, a rounding of the transition is observed due to the expected finite-size scaling. The correlation length of critical fluctuations, as mirrored by the decay length of the adsorbed profile, saturates at a finite value near the critical point.