Magnetic domain structure of Co ultra-thin islands on Ru

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Abstract

Magnetic thin films often present different properties than bulk materials [1]. For example thin films can present larger magnetic anisotropies (up to one order of magnitude larger [2, 3]) than the bulk. These differences arise from the increasing importance of the surface contribution to the magnetic anisotropy when the thickness of a film is reduced.This surface term does not depend of the number of layers, but only on the topological and crystallographic structure of the interface between the substrate and the ferromagnetic film grown on it. Therefore, a good characterization of the surface is crucial for a proper understanding of the magnetic properties of thin films. For example, the discrepancies regarding the magnetization easy-axis in Co/Au(111) reported by Allenspach [4] and Pommier [5] were attributed to differences in the growth mode of the films. Another example is the Curie temperature of Co monolayers, reported to be the same as for bulk, while later work attributed the result to a coverage determination problem[6].

In this work we correlate the magnetic domain structure of Co islands on Ru, measured by spin-polarized low-energy electron microscopy (SPLEEM) with micromagnetic calculations. Three atomic layers thick triangular islands of Co were grown on Ru(0001) by molecular beam epitaxy in-situ in the SPLEEM chamber. Thein-plane magnetized triangular Co islands present two different stacking sequences,reflected in their triangular shape with two different orientations. After applying a magnetic field in a given direction, distinctly different magnetization patterns areobserved on the two island families. One island set has very wide domain walls whilethe other has much thinner walls, indicating their different magnetic anisotropy.Furthermore, the types of islands with narrower domain walls present a pattern witha given chirality.Some tests were performed with the micromagnetic simulation package OOMMF [7] to understand the interplay of applied field direction and island orientation. The simulation reproduces nicely the experimentally observed pattern (Figure 1). Following the micromagnetic simulations for different orientations of the islands relative to the applied magnetic field clarifies the origin of the domain pattern. The local magnetization on the island tends to align with the edges of the triangular island as the external field is removed.

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Figures

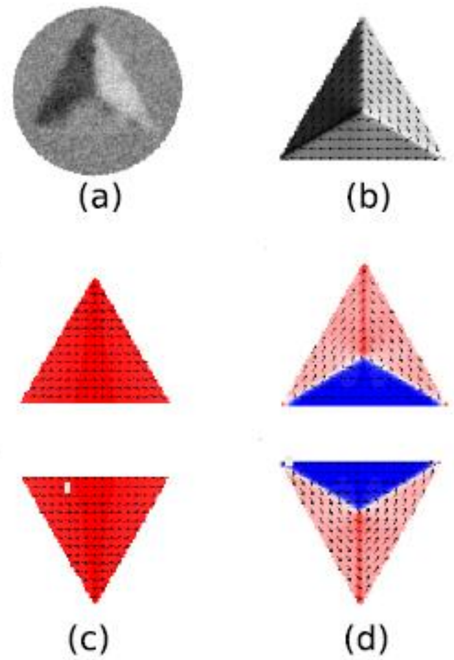

Figure 1. SPLEEM image acquired of 3 ML fcc Co islands. (b) Micromagnetic simulation of a configuration that reproduces the experimental picture. The grey level corresponds to the component of the magnetization along the upper-right islands edge. The arrows indicate the magnetization vector. (c) Single state triangular islands with two orientations. (d) Relaxed configuration after removing the field where the chirality of the pattern depends on the relative orientation of the island and the applied magnetic field.