

1-Dimensional Stacking of Ferromagnetic Nanoparticles in Anodic Alumina

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When magnetic particles align, there is an anisotropic magnetic coupling effect between the particles, which is desirable for many magnetic device applications. Different templates with cylindrical shapes have been used to confine magnetic particles in order to induce this 1-dimensional coupling. Under anodic conditions, the oxidation of aluminum results in the growth of pores whose size and spacing can be directed by adjusting the anodization conditions, making it an attractive template. While most AAO growth results in pores between 50 and 150nm in diameter, conditions are used that produced sub-10nm pores in thin films (50-200nm) of aluminum. Ferromagnetic iron/platinum nanoparticles are then incorporated into these pores. The magnetic properties of the composite films are studied using SQUID magnetometry and magnetic force microscopy. The substrates are studied in three different orientations with respect to the applied magnetic field in order to better understand how the particles align within the pores. The saturation magnetization varied between the different orientations indicating anisotropy in the film. Nanoparticles with a coercive width of 945 Oe showed increases in coercivity of 10-30% when incorporated in the AAO. This increase suggests that the chains of particles are coupling. The films showed normalized remnant magnetization values ranging from 0.15 to 0.4 which are below the expected value of 0.5 for ferromagnetic materials. This suggests that there is anti-ferromagnetic behavior in the system caused by the particles aligning in a zig-zag pattern inside the pores. This work demonstrates a bottom up approach to creating anisotropy in a nanoscale system.