Poster

FABRICATION OF ORDERED ARRAYS OF NANODOTS USING POROUS ALUMINA THIN FILM TEMPLATES

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Nanostructured materials have attracted much research over the recent years, as they provide the critical building blocks for the booming of nanoscience and nanotechnology. Nanostructures have novel properties due to the interplay between the size confinement of electrons in small structures and proximity effects. This is relevant for example in device miniaturization towards the Tbit/in^2 recording density and in the thermal stability of the recorded bits. Nanofabrication by self-organized templates, in particular nanoporous alumina membranes, is being explored intensively due to the fact that it might enable mass production over large areas.

In this work, Al thin films of 1 to 10 microns in thickness were deposited onto Si substrates using electron-beam evaporation and sputtering. Highly ordered hexagonal arrays of alumina nanopores were obtained by anodic oxidation of the Al films (Fig. 1). Pore size and periodicity were controlled by the electrolyte used in the anodization process and by optimizing the parameters of the two-step anodization procedure [1]. Single layer Fe and SiO_2 nanodots and bilayer Fe/FeF_2 exchange biased nanodots were deposited by electron-beam evaporation using the alumina nanopores as a template. The hexagonal arrays of nanodots show high degree of ordering over areas of ~ 1cm^2, while domain sizes are of ~ 0.5 μm^2 (Fig. 1). The average number of nearest neighbours is typically 6.0 ± 0.5, while the average angle between them is 60 º ± 10 º. Average dot size and periodicity range from 30 to 80 nm and from 60 to 100 nm, respectively, with a standard deviation of about 10%. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) images yield a close agreement for those ordering parameters, while the latter show the homogeneity in the height of the nanodots (typically of ~ 25 nm; Fig.1(e)). Magnetization hysteresis loops for the Fe dots suggest the key role of shape anisotropy and the transition from a vortex state to a single domain state as the dot size decreases. Exchange biased Fe/FeF_2 bilayer nanodots show an enhanced squareness in the magnetization loops with respect to the single layer Fe dots, thus suggesting that the exchange coupling with the antiferromagnet yields a magnetic stabilization in the ferromagnetic layer. Finally, a new approach to control the nanopore arrangement by pretexturing the initial Al surface is presented. Hexagonal arrays of SiO_2 nanodots are used as a mold to prepare periodic concave regions on the fresh Al film.

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[1] H. Masuda and K. Fukuda, Science, **268** (1995)1466.

Figure 1. SEM images of porous alumina anodized at 40 V in 0.3 M oxalic acid (a-b), and corresponding Fe nanodots (c-d); 3D AFM image of Fe nanodots (e); SEM image of porous alumina anodized at 25 V in 0.3 M sulphuric acid (f).