NANO-OXIDE FABRICATION ON THIN-FILMS OF CHROMIUM OXIDE AND NICKEL

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Nanometer-scale structures were fabricated by anodic oxidation using scanning probe microscopes on thin films. Thin-films have potentials for technological applications in spin-polarized electron transport devices. We can obtain position-controlled nanostructures on the surface of ferromagnetic materials with required size and shape by the SPM oxidation, and it will be applied to ultra-high-density storage devices. It is expected that the oxidation process changes the magnetism of some materials. Chromium oxide is suitable to observe it, because CrO_2 is only one material which shows the ferromagnetic properties among 3d-metal dioxides, although Cr_2O_3 is antiferromagnetic material [1]. On Ni thin films, one can easily obtain metal-oxide wires which suggest that lateral ferromagnetic metal/insulator/ferromagnetic metal (FM/I/FM) tunnel junction devices can be obtained using this fabrication process [2].

Comparing the oxidation results we determine the optimum conditions at which the continuous lines are definitely fabricated. Two chromium oxide samples and a Ni sample have been used. Chromium oxide was made by natural oxidation of evaporated Cr metal (1 nm) on GaAs (001) at room temperature. One of the samples has an additional aluminum layer (1 nm). Ni (10 nm)/SiO_2(400 nm)/Si(001) was made by MBE. Several experiments have been performed to find the best way to oxidize these thin-films, because our previous study was still on the way to the practical use. The objective is sorting out the tip and mode more suitable. Two kinds of tips, high-doped and Rh coated Si tips, have been tested in dynamic (tapping) and contact modes.

Oxidation results in contact-mode show that the lifetime of the tip plays an important role as with previous studies. The shape of the tip change dramatically the conditions and it makes very difficult to make uniform lines and achieve reproducibility and repeatability of the patterns especially on inhomogeneous surfaces. Dynamic-mode allowed growing more uniform and long lines. The main difference between the results obtained by two kinds of tips is in the threshold voltage. As shown in Fig.1, it is possible to start to obtain oxide lines from 8 V by Rh coated tip, while no visible oxide line was fabricated by high-doped Si tip at the same condition.

We will show some examples of fine oxides on these sample surfaces and will discuss the methodology to achieve a reliable technique with a good reproducibility and repeatability.

References:

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Figure (1) :