SB12

NiO Thin Films with Self-patterned Surfaces for Templates of Nanoparticles

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Magnetic nanoparticles have been investigated from the viewpoint of nanoscience and technology over recent years. Their novel and enhanced physical properties are potentially valuable for applications such as ultrahigh density magnetic recording media and magnetic random access memories(MRAMs). It is still an open problem how to fabricate a regular array of uniform-sized nanoparticles. Furthermore, there is another problem: the thermal fluctuation of magnetic moments on nanoparticles due to the volume reduction.

In previous studies, self-assembling process was employed to fabricate much smaller particles than conventional micro-fabrication techniques, and surface structures such as dislocation networks and atomic steps were applied as templates to align the self-assembled particles[1], [2]. Moreover, it was shown that the exchange coupling between magnetic nanoparticles and a surrounding antiferromagnet is effective to improve the thermal stability of their magnetic moments[3]. In this study, NiO thin films were prepared aiming at the preparation of antiferromagnetic templates as a tool to improve the alignment and thermal stability of magnetic moments of nanoparticles.

NiO thin films were prepared on single crystal MgO[001] substrates by a reactive sputtering method from a metal Ni target in a gas mixture of Ar : O_2=4 : 1. The films were sputter-deposited under various conditions of total gas pressure(p_t), sputtering power(P) and substrate temperature(T_{sub}). Their crystallinity and surface morphology were investigated by *in-situ* RHEED and *ex-situ* non-contact mode AFM (NC-AFM). Moreover, Fe nanoparticles were grown on the NiO thin films by mean of molecular beam epitaxy (MBE). The nominal thickness of NiO and Fe were 50nm and 0.5nm, respectively.

RHEED observation indicated the epitaxial growth of NiO thin films, and AFM observation showed that various characteristic surface structures such as rectangular islands (Fig.1(a)), networks (Fig.1(b)) and rectangular pores (Fig.1(c)) were formed depending on their preparation conditions. The side edges of the islands and pores were oriented in <100> or <110> of NiO. Fe nanoparticles grown on a NiO thin film showed pyramid-like alignment, suggesting that the surface structure of the NiO thin film works as a template of the alignment of Fe nanoparticles. In the presentation, we will discuss on the origin of the pores on NiO thin films and magnetic properties of the Fe nanoparticles.

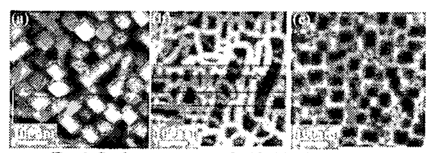

Fig. 1. Surface structures of NiO thin films.
(a): (p_t, P, T_{sub})=(2Pa, 90W, 800°C),
(b): (p_t, P, T_{sub})=(1Pa, 90W, 650°C),
(c): (p_t, P, T_{sub})=(0.5Pa, 100W, 650°C)

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SB13

Domain Imaging of Nano-wires with Perpendicular Magnetic Anisotropy

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Current driven domain wall motion has been reported in many experiment and discussed in various theories. Little experimental attention has been paid to magnetic materials with the perpendicular anisotropy. In this letter we report on domain image of nano-wires with magnetic perpendicular anisotropy. Magnetic nano-wires, 100 to 300 nm wide, are formed from 20nm thick [CoFe/Pt] multilayers grown on a Pt buffer. The nano-wires are fabricated by electron beam lithography and Ar milling. Contact lines are made by patterning Ti/Au films, subsequently deposited on top of the nano-wires. A scanning electron microscopy image of a typical nano-wire is shown in Fig. 1 We achieved the nucleation and the pinning of a single domain wall in a polycrystalline [CoFe/Pt] multilayer controlled by magnetic force microscopy (MFM) measurements

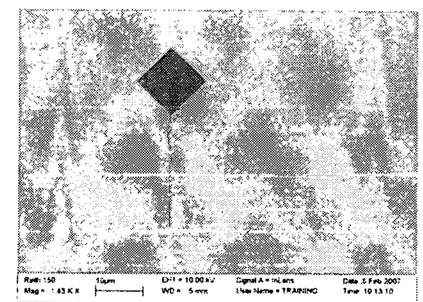

Fig. 1. SEM image of the [CoFe/Pt] multilayer pattern (20nm thick, 100nm wide, 25 um length)

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