Solid State Chemistry - Artificial Lattice Alloys -

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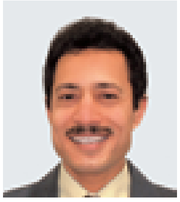

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Assoc Prof SUN Huiyuan Hanbei Normal University, China, 1 October 2000 – 30 September 2001

Dr BACZEWSKI Lech Tomaz Institute of Physics, Polish Academy of Sciences, Poland, 1 April 2001 - 30 June 2001

Scope of Research

Metallic multilayer films have been prepared by ultrahigh vacuum deposition method. Magnetic and electric transport properties of metallic multilayers have been studied by various techniques including ^{57}Fe and ^{119}Sn Mössbauer spectroscopy , x-ray magnetic scattering, and neutron diffraction. Microstructured films such as wires and dots have been successfully prepared by electron beam lithography and novel magnetic and transport properties are investigated.

Research Activities (Year 2001)

Presentations

Magnetic structure of Gd layers in Fe/Gd multilayer films by resonant x-ray magnetic scattering, Hosoito N, Hashizume H (NAIST), Ishimatsu N (JAERI), et al., MML2001, 26 June, Annual Meeting of Phys. Soc. Jpn., 17 September.

Field dependent orientation of sublattice magnetizations in FeRh/NiFe bilayers by Mössbauer spectroscopy, Hosoito N, Nyvlt M (Charles Univ.), Suzuki Y (AIST), et al., Annual Conf. on Magnetics, 25 September.

Spin density wave with the modulation commensurate to the superlattice period in Cr(001)/Sn Multilayers, Mibu K, Takeda M (Tohoku), Suzuki J (JAERI), et al., MML2001, 27 June, Annual Meeting of Phys. Soc. Jpn., 17 September.

Control of magnetic properties by nano-structural engineering, Mibu K, Shinjo T, Int. Conf. on Materials for Advanced Technologies, 4 July.

Magnetism of Cr-based multilayered Films studied using ^{119}Sn Mössbauer spectroscopy, Mibu K, Almokhtar M, Shinjo T, ICAME2001, 7 September.

Temperature dependence of switching field distribution in a NiFe wire with a pad, Shigeto K, Ono T (Osaka), Mibu K, et al., Annual Meeting of Phys. Soc. Jpn., 29 March, MML2001, 28 June, Annual Conf. on Magnetics, 27 September.

Behavior of the vortex core in the magnetic dot under an external magnetic field, Okuno T, Shigeto T, Suzuki Y (AIST), et al., Annual Meeting of Phys. Soc. Jpn, 29 March, Annual Meeting of Phys. Soc. Jpn, 18 September.

Magnetization Configuration of domain wall injected to small contact between two NiFe sub-micron wires, Miyake K, Shigeto K, Suzuki Y (AIST), et al., Annual Meeting of Phys. Soc. Jpn, 18 September.

Conttol of magnetic structure of trilayer film –spin fan of NiFe array-, Shingaki Y, Shigeto K, Mibu K, et al., Annual Meeting of Phys. Soc. Jpn, 17 September.

Topics

Magnetic domain wall in a nano-contact

We report here the magnetic structure and electric resistance of a domain wall (DW) in a nano-contact between two NiFe wires. The sample was fabricated by an electron beam lithography and lift-off method (Fig. 1). The size of the prepared contact in Fig. 1 is 15 × 20 nm^2**.** The thickness of the sample is 10 nm. Figure 2 shows a magnetic force microscopy image of the trapped DW in the contact. The dark signals indicate magnetic charge distribution. The magnetization configuration inferred from a micromagnetics simulation indicates that a small 180 degree Bloch wall is confined in the nano-contact area. The magnetoresistance (MR) curves dropped abruptly when the DW was trapped in the small contact (Fig. 3). García et al. [1] experimentally observed large positive resistance change up to 300 % at room temperature by the confined domain wall in a point contact between two macroscopic Ni wires. On the other hand, we observed the negative DW contribution to the MR, which is understood on the basis of anisotropic magnetoresistance effect around the contact.

1 García et al., Phys. Rev. Lett. **82**, 2923 (1999).

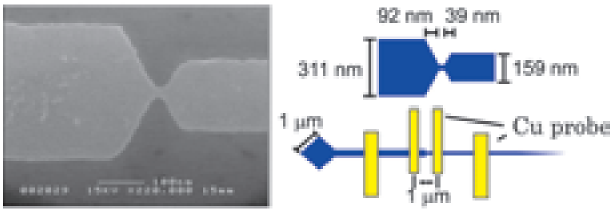

Fig. 1 Illustration of sample structure and SEM image.

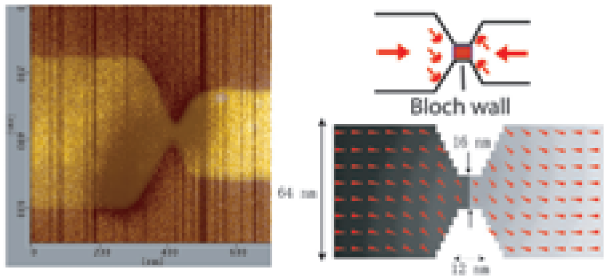

Fig. 2 MFM image and schematic illustration of the magnetic structure.

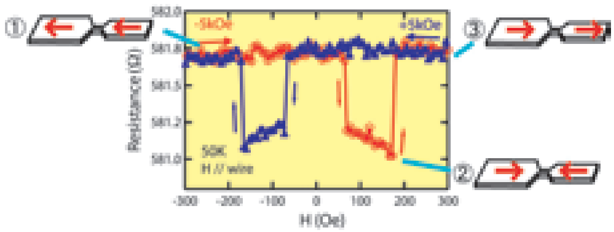

Fig. 3 MR curves of the prepared sample at 50K.

Magnetic structures of Fe/Gd multilayer films investigated by resonant x-ray magnetic scattering technique

Now it becomes possible to investigate magnetic structures of ferromagnetic multilayers by x-ray diffraction technique. Using a resonant x-ray magnetic scattering at Gd L_3 edge, magnetic depth profiles of Gd layers in the [Fe(3.53 nm)/Gd(4.85 nm)]×15 multilayer were determined. The depth-dependent average Gd magnetizations parallel and perpendicular to the applied field are shown in Figs. 4a and 4b. The external field is applied parallel to the film plane and the Gd magnetizations always stay in the film plane. While in a weak field (0.5 kOe), the depth-dependent Gd magnetizations are parallel to the applied field, the perpendicular components are observed in the field of 5.0 kOe. Such behavior is qualitatively understandable by Camley model [1]. However the model predicts a uniform magnetization profile of the parallel component in the weak field region at 10 K. The discrepancy may come from the magnetic anisotropy of the Gd layer, which is not considered in the model. The non-uniform magnetization depth profile in the field of 0.5 kOe indicates that there are depth-dependent distributions in the orientation of the Gd magnetizations and the distribution width is narrower in the interface parts of the Gd layer.

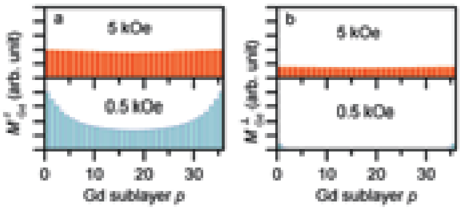

Fig.4 Magnetic depth profiles of Gd layer in an Fe/Gd multilayer at 10K determined by resonant x-ray magnetic scattering.

1 R.E.Camley, Phys. Rev. B**35**, 3608(1987).

Grants

Shinjo T, Magnetic fluctuation of microfabricated magnets, Grant-in-Aid for Scientific Research (C) (2), 1 April 2000 - 31 March 2002.

Hosoito N, Magnetic structures of metallic multilayers by resonant magnetic scattering of circularly polarized synchrotron X-rays, Grant-in-Aid for Scientific Research (C) (2), 1 April 2001 - 31 March 2003.

Mibu K, Control of Magnetic Properties of Nanoscale Magnet by Structural Engineering, Research for the Future Program of Japan Society for the Promotion of Science, 1 September 2000 - 31 March 2001, 1 September 2001 - 31 March 2002.