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Anomalous magneto-resistance ratio of CrO_2/RuO_2 granular bulk system

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Magnetism and magneto-resistance of CrO_2 has attracted attention of many researchers because of the 100 % spin polarization of 3d conduction electrons. In such a half-metallic CrO_2 system, the majority spins have a metallic band structure, while the minority spin band shows a semi-conductive energy gap at the Fermi level E_F[1]. Since the perfect spin polarization should result in the large magneto-resistance (MR), CrO_2 can be expected to be a candidate to develop the spintronics devises such as the magnetic random access memory (MRAM). Especially, we expect that all oxide composites based on the CrO_2 realize the very stable spintronics devises with high performance. However, reported MR ratio (*MRR*) of CrO_2 granular system, containing antiferromagnetic Cr_2O_3 impurity at grain boundaries, showed very small value on the order of -0.1 % at room temperature[2]. Therefore we should search the adequate oxide for the spacer substance between CrO_2 grains.

In the previous reports, Bratkovsky calculated the band structure of $CrO_2/RuO_2/CrO_2$ multilayer system within the linear muffin-tin orbitals method in a supercell geometry with [001] growth direction[3,4]. Here the half metallic ferromagnet of CrO_2 and metallic Pauli paramagnet of RuO_2 have the rutile structure, and they have almost perfect lattice matching with each other. The calculated result showed a half metallic density of state (DOS) at E_F for the $CrO_2/RuO_2/CrO_2$ film. Miao *et al.* studied the MR of epitaxial $CrO_2/RuO_2/CrO_2$ thin film heterostructures grown on the (100) plane of TiO_2 by chemical vapor deposition (CVD)[5]. However they observed very small MR ratio due to the existence of disordered layer at the CrO_2/RuO_2 interfaces. For avoiding such a intermixing between Cr and Ru, we must treat this system at low temperature. Monoharan et al. observed the MR of CrO_2/RuO_2 powder compact with 1 : 1 weight ratio by cold press[6], where the mole ratio x of RuO_2 was about 0.4. Their results of MR ratio were nearly same as that of CrO_2 powder compact.

As mentioned above, experimental result of the enhanced MR has not been reported for the GMR system of $CrO_2/RuO_2/CrO_2$. In the present work, RuO_2 was mixed with CrO_2 , and $(RuO_2)_x$ $(CrO_2)_{1-x}$ powders were sintered at low temperature. The effects of RuO_2 spacer between CrO_2 grains were systematically investigated for the $(RuO_2)_x(CrO_2)_{1-x}$, where x is the mole ratio of RuO_2. After mixing RuO_2 and CrO_2 powders, $(RuO_2)_x$ $(CrO_2)_{1-x}$ were immersed into the organic solution of polymer, then they were naturally dried at room temperature. The effects of RuO_2 spacer between CrO_2 grains were systematically studied for x between 0 and 1. x-dependence of averaged saturation magnetic moment $\overline{\sigma_s}$ linearly decreased with increasing of x. Meanwhile MRR abruptly increased at $x \sim 0.1$. RuO_2 spacer has a possibility to enhance the *MRR* of CrO_2 system, if the natural impurity of Cr_2O_3 and the intermixing of Ru and Cr are eliminated.

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EpitaxialFe and Co films grown on III-V semiconductors by molecular beam epitaxy

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Hybrid systems consisting of ferromagnetic metal (FM) on semiconductor substrates has a great attention for the study of fundamental magnetic properties as well as for the magneto-electronic device applications[1]. We report on the epitaxial ferromagnetic films of Fe and Co on III-V semiconductor substrates using As-free metal molecular beam epitaxy (MBE). As-terminated (2×4) reconstructed surface were prepared for all FM film growth in III-V semiconductor MBE. The morphology changes depending on lattice mismatch with the substrates were studied using *in situ* stress measurement, reflection high energy electron diffraction, atomic force microscopy, and x-ray diffraction. The Fe films grown on the III-V substrates show high-quality bcc crystal structure at room temperature with minimized compound formation at the interfaces. The Fe film grown on lattice matched $In_{0.2}Ga_{0.8}As$ surface indicates that growth proceeds via Frank-van der Merwe mode while the film on InAs(001) substrate grows in Volmer-Weber mode.

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