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**Anomalous magneto-resistance ratio of CrO<sub>2</sub>/RuO<sub>2</sub> granular bulk system**

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

In the previous reports, Brakovsky calculated the band structure of CrO<sub>2</sub>/RuO<sub>2</sub>/CrO<sub>2</sub> multilayer system within the linear muffin-tin orbitals method in a supercell geometry with [001] growth direction<sup>3,4</sup>. Here the half metallic ferromagnet of CrO<sub>2</sub> and metallic Pauli paramagnet of RuO<sub>2</sub> have the nule 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<sub>2</sub>/RuO<sub>2</sub>/CrO<sub>2</sub> film. Miao *et al.* studied the MR of epitaxial CrO<sub>2</sub>/RuO<sub>2</sub>/CrO<sub>2</sub> thin film heterostructures grown on the (100) plane of TiO<sub>2</sub> by chemical vapor deposition (CVD)<sup>5</sup>. However they observed very small MR ratio due to the existence of disordered layer at the CrO<sub>2</sub>/RuO<sub>2</sub> 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<sub>2</sub>/RuO<sub>2</sub> powder compact with 1 : 1 weight ratio by cold press<sup>6</sup>, where the mole ratio  $x$  of RuO<sub>2</sub> was about 0.4. Their results of MR ratio were nearly same as that of CrO<sub>2</sub> powder compact.

As mentioned above, experimental result of the enhanced MR has not been reported for the GMR system of CrO<sub>2</sub>/RuO<sub>2</sub>/CrO<sub>2</sub>. In the present work, RuO<sub>2</sub> was mixed with CrO<sub>2</sub>, and (RuO<sub>2</sub>)<sub>x</sub>(CrO<sub>2</sub>)<sub>1-x</sub> powders were sintered at low temperature. The effects of RuO<sub>2</sub> spacer between CrO<sub>2</sub> grains were systematically investigated for the (RuO<sub>2</sub>)<sub>x</sub>(CrO<sub>2</sub>)<sub>1-x</sub>, where  $x$  is the mole ratio of RuO<sub>2</sub>. After mixing RuO<sub>2</sub> and CrO<sub>2</sub> powders, (RuO<sub>2</sub>)<sub>x</sub>(CrO<sub>2</sub>)<sub>1-x</sub> were immersed into the organic solution of polymer, then they were naturally dried at room temperature. The effects of RuO<sub>2</sub> spacer between CrO<sub>2</sub> grains were systematically studied for  $x$  between 0 and 1.  $x$ -dependence of averaged saturation magnetic moment  $\sigma_s$  linearly decreased with increasing of  $x$ . Meanwhile MRR abruptly increased at  $x \sim 0.1$ . RuO<sub>2</sub> spacer has a possibility to enhance the MRR of CrO<sub>2</sub> system, if the natural impurity of Cr<sub>2</sub>O<sub>3</sub> and the intermixing of Ru and Cr are eliminated.

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**Epitaxial Fe 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 (2x4) 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<sub>0.3</sub>Cd<sub>0.7</sub>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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