Morin Transition Temperature Control of Antiferromagnetic α-Fe_2O_3 Films with Epitaxial Strains

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It is well known that hematite(α-Fe_2O_3) undergoes a spin reorientation transition known as Morin transition at around 263K. Below the temperature, all the spins are along the c-axis direction and above the temperature, they are in the c-plane. It is a very unique transition only found in hematite and some orthoferrites. The theoretical explanation on the origin of the Morin transition was proposed by J. O. Artman, J. C. Murphy, and S. Foner[1]. They suggested that it is caused by the competition between the single ion anisotropy and the magnetic dipole anisotropy. Their model has been confirmed with the fine particles and pressurized single crystal and it becomes clear that the lattice constants in c-plane are critical to determining the Morin temperature[2,3]. However, when Fe_2O_3 are grown in the form of epitaxial films, no one has observed the transition despite the expectation that the epitaxial strain can be controlled better in the this form by an interaction with the substrates[4,5].

In this work, we have grown a series of epitaxial α-Fe_2O_3 films on Al_2O_3 substrates. The lattice constants of them are successfully controlled with the Cr_2O_3 buffer layer and the strain relaxation with thickness. The existence of remnant ferromagnetic phases was excluded by measuring X-ray magnetic circular dichroism (XMCD) of Fe $L_{2,3}$ edges. The Morin temperatures were also measured with X-ray magnetic linear dichroism (XMLD) of FeL_2 edge. The lateral lattice constants were measured with grazing incidence X-ray diffraction (GIXRD). We found that the Morin temperature changes consistently with the lattice constants and it reaches 360K for the thinnest film. The results are well in accordance with the theoretical model proposed by Artman, Murphy, and Foner.

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