Room Temperature Ferromagnetic Behaviors in $Fe_{2-x}Ti_{1+x}O_5$ Solid Solution Thin Films Fabricated by a Pulsed Laser Deposition

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Spintronics, which exhibits irreplaceable merits like non-volatility and energy efficiency, has been considered to play a significant role in future electronic devices. Lots of efforts have been carried out to study a wide variety of ferromagnetic (FM) materials, especially oxide systems like SnO_2, In_2O_3 and $La_{0.67}Sr_{0.33}MnO_3$ [1-2]. Recently, Fe_2TiO_5 had attracted many interests for the non-toxic, low-cost, environmentally abundant, and remarkably stable advantages of its components α-Fe_2O_3 and TiO_2.

In this work, we offered an opening report on the successful fabrication of a series of orthorhombic Fe_2TiO_5-$FeTi_2O_5$ solid solution thin films grown on $SrTiO_3$ (100) substrates by pulsed laser deposition. The single phase with crystal orientation of (230) was revealed by XRD patterns (Fig 1), and the difference of composition among grown thin films was confirmed through the peak shifts in XRD and changing ratios of Fe^{2+} and Fe^{3+} ions in XPS results proved by curve fittings on Fe $2p_{3/2}$ peaks. The indirect energy bandgap of Fe_2TiO_5 was also calculated to be approximately 2.1 eV through optical absorption and Tauc relationship.

Then, we gave the first experimental confirmation on strong ferromagnetic behaviors at room temperature (300K) in both $Fe_{2-x}Ti_{1+x}O_5$ (x = 0.5 and 0.7) samples (Fig 2), with saturation magnetization of about 24 emu/cm^3 and 20 emu/cm^3, respectively. It was intriguing that FM manner can still be exhibited at 400K in $Fe_{1.5}Ti_{1.5}O_5$ films (the inset of Fig 2), which indicates its Curie temperature is higher than 400K. Besides, the double-exchange mechanism between localized 3*d* magnetic moments was possibly responsible for the origin of ferromagnetism. These results might lay a solid foundation as an available candidate for future cost-effective spintronics devices.

This research was partially supported by Basic Research Grant (Hybrid AI) of Institute for AI and Beyond for the University of Tokyo.

References

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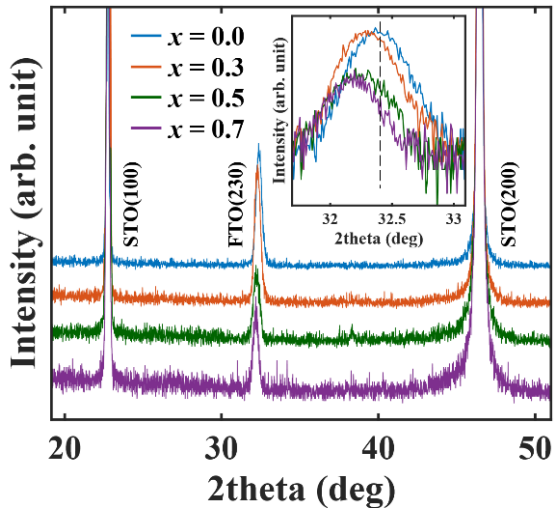

Fig 1. XRD 2θ/ω patterns of as-grown (230)-oriented $Fe_{2-x}Ti_{1+x}O_5$ (x=0~0.7) films. The inset shows a zoom-in overlapped region at near 32.5°.

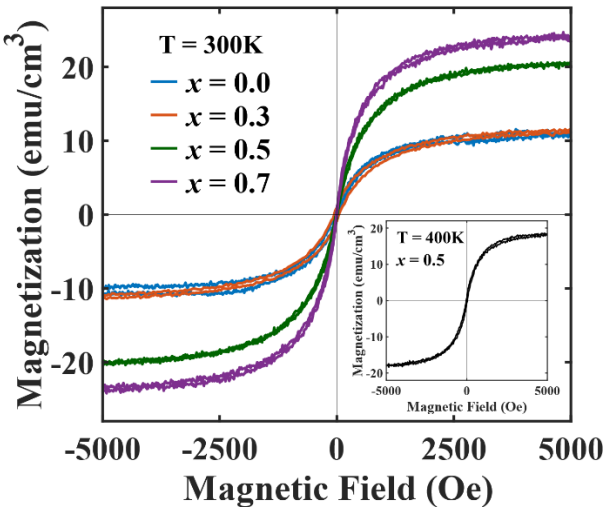

Fig 2. M-H curves of as-grown $Fe_{2-x}Ti_{1+x}O_5$ (x=0~0.7) films measured at room temperature. The inset shows M-H curve of $Fe_{1.5}Ti_{1.5}O_5$ films measured at 400K.