

## Epitaxial growth of cobalt ferrite (111) thin films on sapphire (0001) substrate using RF sputtering

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A previous report showed that the cobalt ferrite (CFO) (111) thin films grown by different methods present difficulties with regard to thin films quality and magnetic properties [1, 2]. This suggests that the magnetic properties of the CFO(111) films are dependent on film thickness and deposition parameters. In this study, we report the magnetic properties of CFO(111) thin films grown on  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>(0001) at different deposition temperatures. The purpose of this research is to understand the optimum temperature conditions for growth of better quality CFO(111) thin films.

Epitaxial thin films of Co<sub>x</sub>Fe<sub>3-x</sub>O<sub>4</sub> (CFO) (111) were grown on single crystal  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>(0001) substrates using RF sputtering. A metallic alloy target of CoFe (Co: Fe=1:3) was used, for reactive sputtering. The total pressure of Ar and O<sub>2</sub> gas inside the sputtering chamber was maintained at 0.5 Pa. These substrates were annealed at growth temperature for one hour under vacuum prior to deposition. The films were deposited at various substrate temperatures ( $T_s$ ) of 300°C, 400°C, 500°C, 550°C, and 600°C.

The RHEED pattern was ascertained before and after the experiment to observe the structural growth of the films. RHEED measurements show a spotty pattern at low temperatures but a streaky pattern at higher temperatures. X-ray reflectometry suggested that film thickness was about 50 nm. In the magnetic hysteresis loops presented in Figure 1(a) out-of-plane saturation magnetization increased with the increase of  $T_s$  and reached to 381 emu/cm<sup>3</sup> as  $T_s = 600$  °C. Figure 1(b) shows that the saturation magnetization is larger at a higher growth temperature, close to the bulk value of CFO. This suggests that single crystalline thin films may develop at higher temperatures.

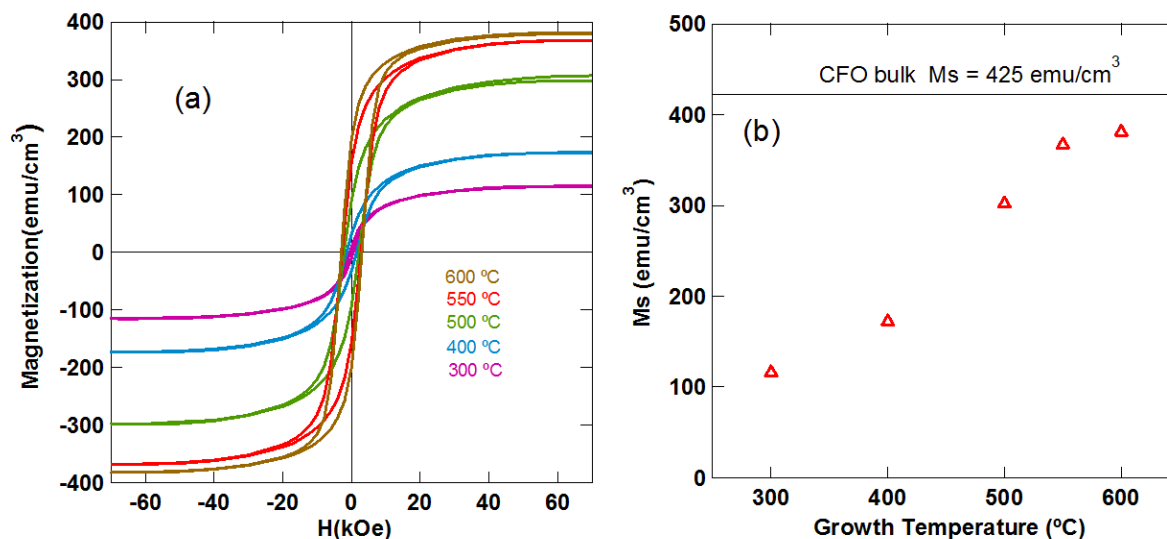


Fig. 1(a) M-H loops of CFO (111) thin films grown at different temperature. , (b) Saturation magnetization (out of plane) vs. Growth temperature of CFO (111) thin films

### Reference

- 1) H. Yanagihara *et al.*, *J. Appl. Phys.*, **109** (2011) 07C122.
- 2) C.-W.Cho *et al.*, *J. Magn. Mater.*, **368** (2014) 149–154.