

Fe-O 膜のピンホール密度と 90 度磁気結合実現の関係

Pinhole density in Fe-O film and 90 degree magnetic coupling

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It has been theoretically reported that spin transfer torques (STT) in antiferromagnetic (AFM) materials should be obtained^[1], and the supporting experimental evidences have been reported^[2,3]. However, STT in AFM has never been observed because of the strong exchange coupling between adjacent atoms. Therefore, we try to fabricate the quasi AFM layer which has stripe domains with alternately antiparallel magnetization to each other by using 90 degree magnetic coupling between two ferromagnetic (FM) layers through Fe-O layer. In this report, the relationship between the pinhole density in Fe-O film and 90 deg magnetic coupling was investigated.

Ta5/Ru2/Ir₂₂Mn₇₈5/Co₉₀Fe₁₀2(A)/Fe-O1/Co₉₀Fe₁₀2(B)/Cu3/Co₉₀Fe₁₀2.5(C)/Cu1/Ta5 (unit: nm) films were sputtered on thermal oxidized Si wafer. We prepared two kinds of samples (a) and (b) with Fe-O fabricated by the natural oxidation process in the chamber (a) and (b), respectively. After depositing Fe, the oxygen gas was introduced into each chamber and the exposure was 50 kL. The deposited films were annealed in a field of 4.1 kOe at 270 °C for 1 h.

Figure 1 shows *MH* loops measured along 90 deg to the annealing field. Although the sample (a) shows 90 deg magnetic coupling, the sample (b) does not have it as shown Fig. 1.

Figure 2 shows a cross sectional transmission electron microscope (TEM) image of the film with Fe-O fabricated in the chamber (b). The pinhole length of the film with Fe-O fabricated in the chamber (a) is 16 % and that in the chamber (b) is 42 %. It became obvious that Fe-O film with the less pinhole provides 90 deg magnetic coupling. It is considered that since the pinhole area has the ferro-coupling, we cannot obtain the balance of ferro- and antiferro-coupling energy through Fe-O.

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[2] Z. Wei *et al.*, Phys. Rev. Lett. **98**, 116603 (2007).

[3] T. Moriyama *et al.*, J. Appl. Phys. **106**, 162406 (2015).

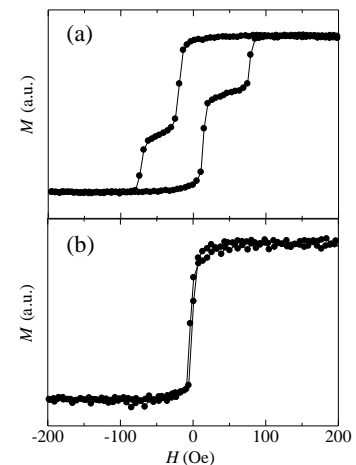


Fig. 1. *MH* loops in 90 deg (a) before and (b) after the sputtering system remodeling.

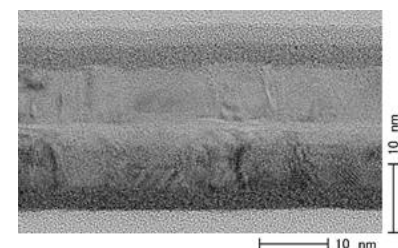


Fig. 2. The cross sectional transmission electron microscope (TEM) image for the film with Fe-O fabricated in the chamber (b).