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Synthetic Antiferromagnet CoFe/Ru/CoFe/FeMn을 가진 스핀 밸브 구조의 거대자기저항 특성

GMR Properties of Spin Valve Structures with Synthetic Antiferromagnet CoFe/Ru/CoFe/FeMn

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1. Introduction

Synthetic spin valves are of interest as read head for high density magnetic recording over 10 Gbit/in^2 because of good thermal stability and large dynamic range due to the improved magnetic bias of the free layer[1]. Using synthetic antiferromagnet can remove the canting of magnetization of the free layer caused by the magnetostatic field arising from the pinned layer. Another advantage of the synthetic antiferromagnet consisting of a CoFe(Co)(t_{P1})/Ru/CoFe(Co)(t_{P2}) is reducement of net torque of two pinned layers to external field or field due to sensing current[2]. Basically, the net torque of two magnetic layers can be obtained from same thickness of two magnetic layers with same coercivity and magnetization. But, it seems very difficult to deposit magnetic layers with same coercivity. Therefore, it is desirable to give thickness difference between two magnetic layers in practical process for zero net torque.

In this study, we have changed the thickness of two magnetic layers separated by Ru, and investigated the effect of thickness difference on interlayer coupling field and a strange R-H curve behaviors.

2. Experiment

We have made top synthetic spin valves with structure Ta/ NiFe/CoFe/Cu/CoFe(P1)/Ru/CoFe(P2)/FeMn/Ta on Si (100) substrate with natural oxide. Samples were deposited in Ar pressure of 1 mTorr by dc magnetron sputtering system with a typical base pressure of 5-6 x10^{-7} Torr. The deposition rate was controlled within 1-3Å/sec for each metal and sputtering rate calibrations were performed by P1 machine. The GMR and magnetization measurements were carried out using a four point probe(at low field and high field) and a vibrating sample magnetometer, respectively. Surface profiles of samples were observed by Atomic Force Microscope(AFM)

3. Results and discussion

We have changed only the thickness in free layers and the thickness difference (P1-P2) in two ferromagnetic layers separated by Ru, and investigated the effect of

magnetic film thickness on interlayer coupling field in spin valve with synthetic antiferromagnets. Fig. 1 shows interlayer coupling field as a function of the thickness of free layer in top synthetic spin valves. As the thickness of free layer decreases, interlayer coupling field increases rapidly. It should be noted that reducement of interlayer coupling field has to be considered for thinner free layer being able to used in high sensitivity recording head. Fig. 2 shows thickness difference(P1-P2) dependence of interlayer coupling field for the top synthetic spin valves with structure Si/Ta/NiFe/CoFe/Cu/CoFe(P1)/Ru/CoFe(P2)/FeMn/Ta. In case of P1>P2, interlayer coupling field agreed well with the Modifed Neel model suggested in conventional spin valve structures as shown in Fig. 2[3]. However, in case of P1≤P2, we found that the interlayer coupling field would not be able to be explained by the Modified Neel Model. More detail results in synthetic spin valves in relation with thickness difference between two ferromagnetic layers will be presented in conference site.

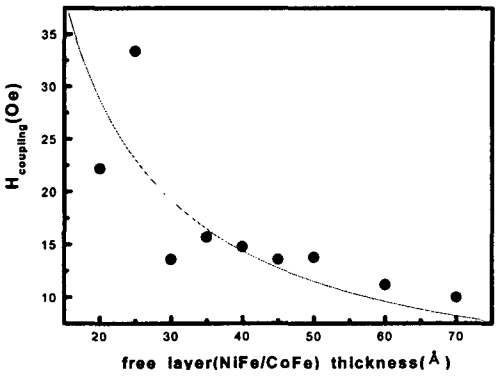

Fig. 1 Interlayer coupling field as a function of thickness of free layer for the top synthetic spin valves.

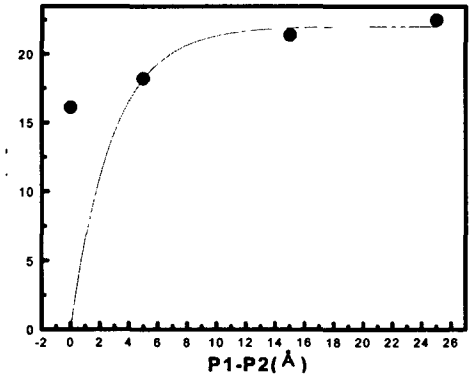

Fig. 2 Thickness difference(P1-P2) dependence of the synthetic spin valves with structure Si/Ta/NiFe/CoFe/Cu/CoFe(P1)/Ru/CoFe (P2)/FeMn/Ta. (solid line is from Model and soild circles are from experiment)

4. References

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