

MgO 기반의 자기터널접합에서 NiFeSiB/Ru/CoFeB 합성형 자유층의 효과

MgO based Magnetic Tunnel Junctions with NiFeSiB/Ru/CoFeB Synthetic Free Layer

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1. Introduction

The synthetic ferromagnetic free (SyF) layers have been investigated to achieve a lower switching current density and a higher thermal stability in spin transfer torque (STT) switching. The SyF free layers composed of CoFeB / Ru / CoFeB layers coupled anti-parallel are effective to lower the switching current density due to spin accumulation at the interface between CoFeB and Ru layer [1]. The SyF free layers consist of parallel coupling of soft magnetic layer and hard layer are also effective. As soft ferromagnetic layers are expected helping a switching of the hard ferromagnetic layer [2]. However the exact mechanism of SyF free layer and other kinds of SyF system has not been clarified yet. To investigate a new kind of SyF free layer, amorphous NiFeSiB layer was applied as a soft magnetic layer.

2. Experiment

We fabricated MgO-based MTJs with CoFeB / Ru / NiFeSiB synthetic free layers, and investigated tunnel magnetoresistance (TMR) depending on the thickness of Ru layer. The film layers were, starting from the substrate, Ta(5) / Ru(40) / IrMn(7.5) / CoFe(3) / Ru(0.85) / CoFeB(4) / MgO(1.9) / CoFeB(2) / Ru(t)/NiFeSiB(2.67)/Ta(5)/Ru(5) (in nm). The Ru spacer layer was varied in thickness from 0.6 to 1.2 nm.

3. Result and discussion

The CoFeB / Ru / NiFeSiB trilayer showed the strongest exchange coupling in case of 1.0 nm Ru thickness (not shown here). The TMR ratio was around 200% (these values were higher than conventional CoFeB SyF free layered MTJs) except 1.0 nm Ru thickness, TMR ratio was decreased to nearly 110% when Ru was 1.0 nm (Fig. 1). The RA value was varied depending on the Ru thickness with same MgO thickness. The TMR and RA value are depend on the thickness of Ru layer which is related to exchange coupling strength.

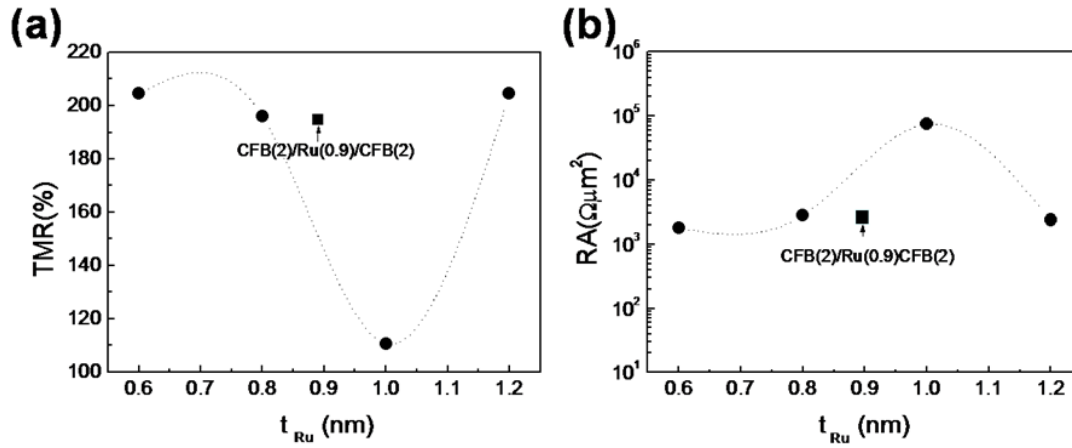


Fig. 1. (a) TMR ratio and (b) RA values as a function of Ru thickness. All MTJs have a 1.9 nm MgO barrier and CoFeB(2)/Ru(1.0)/NiFeSiB(2.67) free layer structure, except for the square dot which indicate a TMR and RA value of CoFeB(2)/Ru(0.9)/CoFeB(2) free layer.

4. References

- [1] J. Hayakawa et al., Jpn. J. Appl. Phys. 45, L1057 (2006).
- [2] C-T. Yen et al., Appl. Phys. Lett. 93, 092504 (2008).

Key Words: Magnetic tunnel junction, synthetic antiferromagnetic layer, NiFeSiB, exchange coupling