Magnetic tunnel junctions stabilized by modified synthetic antiferromagnets

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In a conventional magnetic tunnel junction (MTJ) where a pinned layer is exchange-biased by a synthetic antiferromagnet (SAF), the stray field from the pinned layer often causes poor switching asymmetry due to the thickness difference between two ferromagnetic layers separated by a Ru spacer [1]. To attain good bias point control, a modified synthetic antiferromagnet (MSAF) structure, consisting of an additional Ru/ferromagnet onto the SAF, was suggested [2]. In this study, we evaluate MR transfer characteristics with an attention paid on the bias point of an MTJ with an MSAF. A series of micromagnetic computations based on solving LLG equation was performed. The structure considered is as follows: IrMn(9.0) / CoFe(P1, 1.5) / Ru(0.7) / CoFe(P2, 3.0) / Ru(0.7) / CoFe(P3, 1.5) / Al_2O_3(1.5) / CoFe(1.6) / NiFe(3.2) (in nm). The key parameters considered include indirect exchange coupling energy between the ferromagnetic pinned layers, i.e., P1/P2 and P2/P3, and exchanging bias energy between IrMn and P1. In this study, it was assumed that the magnetization direction of P1 layer was 11° canted relative to the applied field direction due to magnetization flop during film growth. The cell dimension was fixed at 0.5 ㎛ × 0.5 ㎛. As shown in Fig 1, the field sensitivity near zero field is higher than that of the conventional MTJ structure. In addition, the effective exchange bias field $H_{ex,eff}$ increased as indirect exchange coupling energy increased.

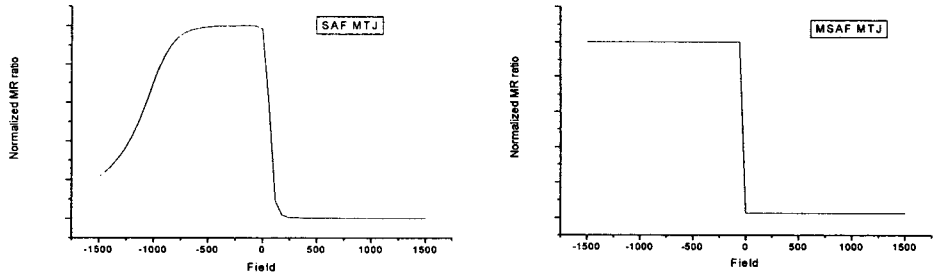

Fig. 1. MR transfer curves of MTJs with SAF (left) and MSAF (right).

References

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