

Components-dependent magnetic switching of CoFeB and CoFeSiB magnetic tunnel junction

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1. Abstract

Two kinds of amorphous Co-rich magnetic amorphous films of CoFeB and CoFeSiB of different compositions were prepared by magnetron sputtering and applied as ferromagnetic electrodes in magnetic tunnel junctions (MTJs). The spin polarization of CoFeB is rather sensitive to its composition, but not necessarily to magnetic switching behavior. The switching fields were around 30 Oe for Co contents ranging from 60 to 85 at. %). On the contrary, the switching behavior of CoFeSiB was very sensitive to its Co content (5 to 20 Oe as Co content increased from 71 to 81 at. %), with tunneling magneto-resistance (TMR) ratio saturated when Co surpass 74 at. %. Comparatively, CoFeSiB can be a good candidate for future high density spin memory devices to reduce the switching field or critical current with its excellent adjustable soft magnetic behavior and high spin polarization by properly adjust the contents of metalloid elements Si and B. The Landau-Lifshitz-Gilbert micromagnetics simulation was employed to investigate the size dependence of MTJs with magnetically soft CoFeSiB free layer with ellipsoidal cells with sizes from 1 μm to 60 nm, using the magnetic parameters extracted from the experiment. The switching field needed was smaller compared to that of the Co [1] and CoFe [2] junctions but slightly larger than that of the NiFe [3] junction at corresponding sizes reported. Above-mentioned features associated with amorphous CoFeSiB junction appear attractive for MRAM applications.

2. References

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Composition	H_c (Oe)	M_s (erg/cm ³)	TMR (%)	H_{sw} (Oe)
Co _{70.5} Fe _{4.5} Si ₁₅ B ₁₀	1	400	21	3
Co ₇₄ Fe ₄ Si ₁₄ B ₈	1	600	23	5
Co ₇₆ Fe ₄ Si ₁₃ B ₇	118	112100	26	10
Co ₈₁ Fe ₂ Si ₁₀ B ₇	135	135000	28	12
Co ₆₀ Fe ₂₁ B ₁₉	2	900	21	12
Co ₇₃ Fe ₁₄ B ₁₃	2	1000	23	13
Co ₈₁ Fe ₁₀ B ₉	2	1050	24	14
Co ₈₅ Fe ₈ B ₇	3	1150	18	15

Table 1. Magnetic properties changes as a function of the composition for CoFeB and CoFeSiB. The H_c and M_s values were taken from films (about 400nm) whereas and TMR and H_{sw} from MTJs.

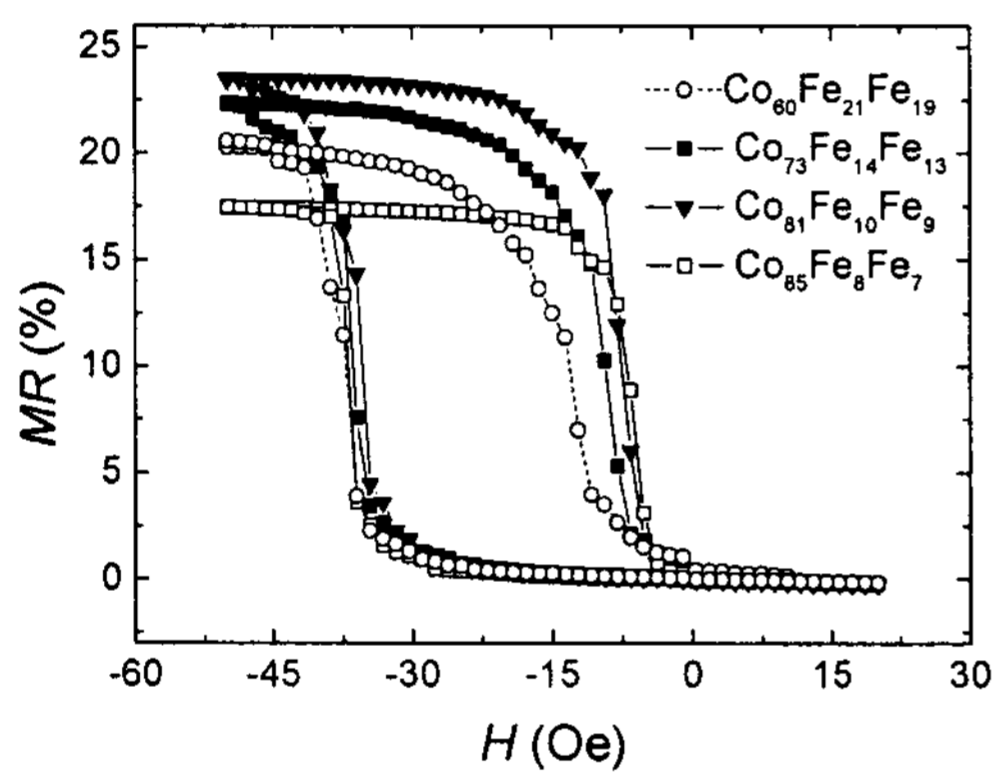


Fig. 1.

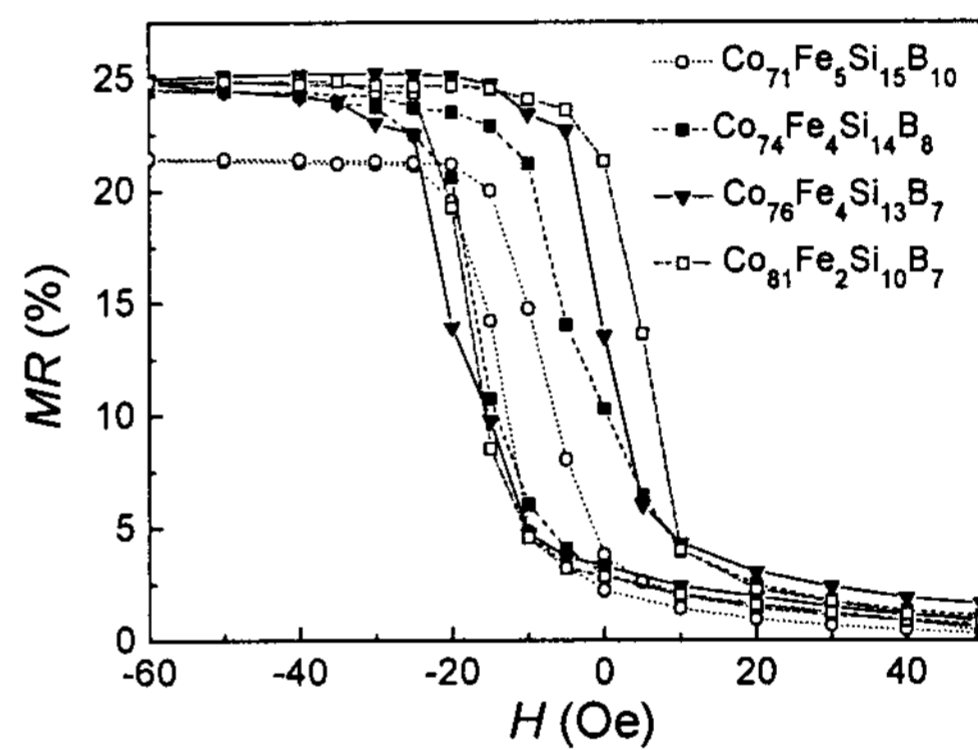


Fig. 2.

Fig. 1. TMR ratio and H_{sw} with respect to the Co composition change in amorphous CoFeB alloys.

Fig. 2. TMR ratio and H_{sw} with respect to the Co composition change in amorphous CoFeSiB alloys.