Influence of configurative parameters on the characteristics of CPP spin valves, a prediction from Mathlab simulation using simple 2CSR model

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The magnetoresistance (MR) ratio of current perpendicular to plane (CPP) spin valves is both fundamental and technological interest. Technologically, it is useful for fabrication of sensors and read-heads. Our target is the read-heads with a density of 300Gb/in.^{2}. CPP spin valve elements will be fabricated by photolithography and ion-beam etching. We should consider the influence of configurative parameters on the characteristics of this structure. The Mathlab simulation using simple two-current series-resistor (2CSR) model can be a suitable tool for this consideration. Our results of Mathlab simulation in some sences are consistent with the experimental results of refs. [1-6] and show more clearly these influences. We have found that the specific resistance is slightly increased in both parallel and anti-parallel components as increasing the thickness of non-ferromagnetic (NF) layers, whereas MR ratio is decreased. We can expect an enhancement of specific resistance and MR ratio by increasing the thickness of ferromagnetic (FM) layers. From the contact resistant dependence of MR ratio for different number of FM layers, we can suggest that in the range of contact resistance from $10^{-15}\Omega$ to $10^{-14}\Omega$ the MR ratio strongly depends on the FM layer number. The MR becomes independent of FM layer number and saturates when the contact resistance goes down to value of $10^{-17}\Omega$. In our simulation, we assumed the factors of anisotropic electron scattering in the FM layers and at the FM/NM interfaces are β=0.6 and γ=0.7, respectively.

References

[1] Masanori Hosomi, et al., *J. Appl. Phys.* **91** (2002), 8099.
[2] J. Bass, W.P. Pratt Jr., *Physica B* **321** (2002), 1.
[3] S.-F. Lee, et al., *J. Magn. Magn. Mater.* **118** (1993), L1.
[4] H. Yuasa, et al., *J. Appl. Phys.* **92** (2002), 2646.
[5] J. Bass, W.P. Pratt Jr., *J. Magn. Magn. Mater.* **200** (1999), 274.
[6] Satoru Araki, et al., *J. Appl. Phys.* **87** (2000), 5377.