MAGNETOSTATIC INTERACTION IN SPIN VALVE STRUCTURE WITH PERPENDICULAR ANISOTROPY

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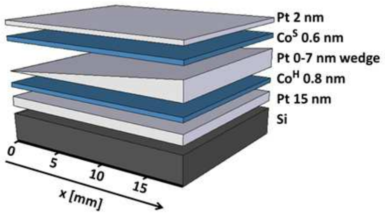
Introduction

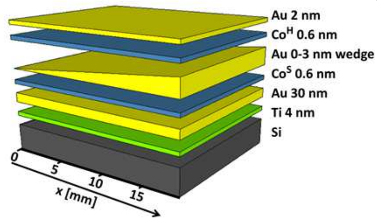
In layered structures of the pseudo-spin-valve (PSV) type the magnetization reversal is determined not only by magnetic properties of ferromagnetic sublayers but also by interactions occurring between them. For applications important is not only reversal of the whole PSV structure represented by major loop but also reversal of magnetically soft layer (minor loop). It was previously demonstrated that reversal of the soft layer depends on magnetic structure of the hard layer. In particular, for multi-domain state of the magnetically hard layer the reversal of the soft layer takes place in two steps with characteristic intermediate level corresponding to creation of **duplicated domains.**

The sample - pseudo spin-valve (PSV) with perpendicular anisotropy

Morphology (Pt spacer)

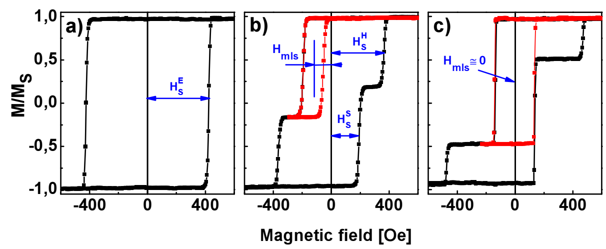


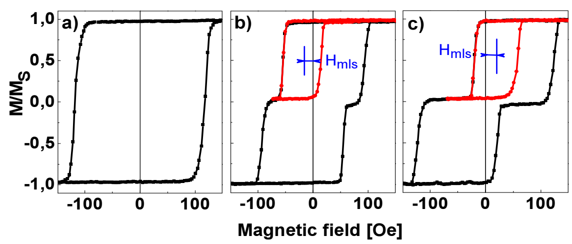
Morphology (Au spacer)



Co^S and Co^H ferromagnetic sublayers characterized by perpendicular anisotropy.

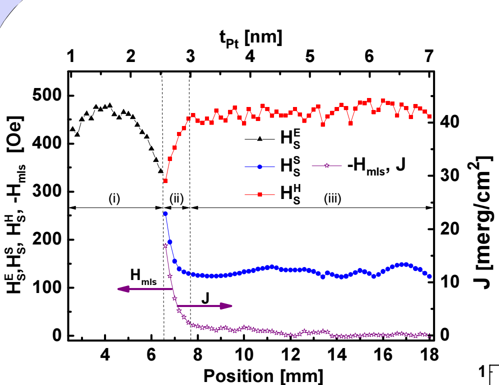
Wedge shaped spacer layer determine changes of coupling as a function of the thickness of nonmagnetic spacer.



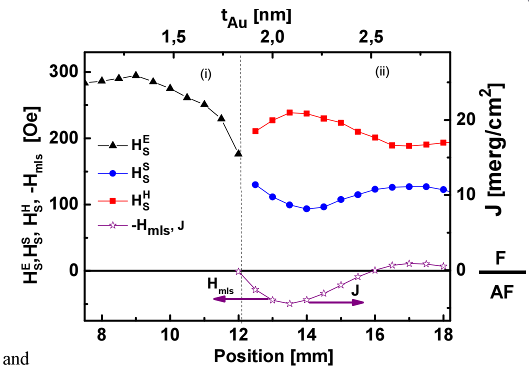


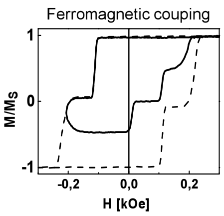
PMOKE major and minor loops. The following parameters are determined from these loops: the individual switching fields H_S^S and H_H^S of the Co^S and Co^H layers, respectively, a collective switching field H_E^S for the case of a cooperative reversal of both layers, the field-position of the center of the minor loop H_{mls}.

Replication of domains

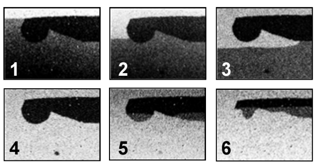


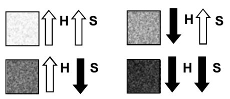
In both samples the Co layers have perpendicular anisotropy. The wedge shaped spacer ensures different switching fields (H_S^S and H_S^H for the Co^S and Co^H layers, respectively) for spacer thicknesses $t_{Au} \geq 1.7$ nm and $t_{Pt} \geq 2.6$ nm for S^{Au} and S^{Pt}, respectively. For the S^{Au} sample the effective interlayer coupling (J) oscillates with t_{Au} and is antiferromagnetic ($J<0$) for $1.8 \leq t_{Au} \leq 2.3$ nm and ferromagnetic ($J>0$) for $t_{Au} \leq 1.8$ nm and $t_{Au} \geq 2.3$ nm. In the S^{Pt} sample the coupling is ferromagnetic for $2.6 \leq t_{Pt} \leq 3$ nm, is strongly decreases with t_{Pt} and for $t_{Pt} \geq 2.3$ nm it is close to zero.

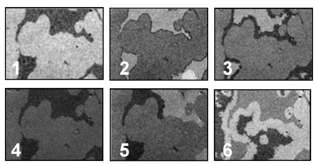




Major loops (dashed line) and representative hysteresis loop (only the part for increasing magnetic field) recorded for partially reversed magnetically hard layer. Soft layer changes magnetization in two steps.







Domain structure recorded with P-MOKE microscope. The numbers 1-6 correspond to magnetization reversal process with ferromagnetic copying of domains from Co^H to Co^S.

Acknowledgements

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Conclusions

The study of the minor hysteresis loops, registered when the Co^H was only partially reversed was performed for both samples. The form of the minor loops measured at a position corresponding to J ¹ 0 allowed us to prove that the magnetization reversal takes place through a distinct intermediate state corresponding to the copying of domains from Co^H to Co^S layer.