UC03

Size Effect on NiFe/Cu/NiFe/IrMn Spin-valve Structure for an Array of PHR Sensor Element

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Ar ion beam etching was done on NiFe(6)/Cu(1.5)/NiFe(4)/IrMn(20) multilayer spin-valve structure with three different beam voltages in order to optimize the effective beam voltage for patterned Planar Hall device fabrication. VSM characterizations were done before and after etching to know the necessary exchange bias and influence of etching. After etching the multilayer spin-valve structure exhibits enhanced exchange bias from 202 Oeto 314 Oe for the etching beam voltage of 800 V. Similarly, the corresponding coercivity of the spin-valve structure before etching is 113 Oe while it is increased to 179 Oe. Ar ion beam etching was done for different patterned junctions with different dimensions of $50\times50\ \mu m^2$, $20\cdot20\ \mu m^2$ and $5\times5\ \mu m^2$ prepared by lithography technique. The PHE measurements were carried out for all three junctions. Sensitivity has been found to be more as the size of the patterned junction becomes smaller and smaller.

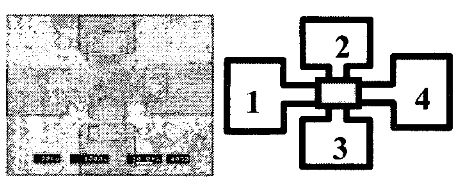

Fig. 1. SEM photo of fabricated $5\times5\ \mu m^2$ PHR device in the left and schematic diagram of electrical connections in the right for PHR measurements.

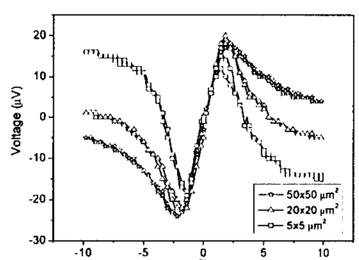

Fig. 2. The profiles of experimental PHE voltages as a function of applied magnetic field for different sensor element dimensions

REFERENCES

[1] Y.Bason, L. Klein, J. B. Yau, X. Hong, and C. H. Ahn, Appl. Phys. Lett. **84**, 2593 (2004).

[2] Z. Q. Lu, G. Pan, W. Y. Lai, J. Appl. Phys. **90**, 1414 (2001)

[3] B. H. Miller and D. Dahlberg, Appl. Phys. Lett. **69**, 3932 (1996)

[4] M. Gruyters, J.Appl. Phys. **95**, 2587 (2004)

[5] Z. Q. Lu, G. Pan, W. Y. Lai, J. Appl. Phys. **90**, 1414 (2001)

UC04

Thermal stability and Mn diffusion behavior of spin valves incorporating a new TiAl alloy film as capping layer

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The under/capping layer materials used in spin valve (SV) have a significant effect on the interface uniformity, texture, crystallinity, thermal stability, and their magnetoresistive properties [1-3]. Although a Ta capping layer prevents oxidation effectively because it forms a stable passive layer, Ta-based SVs degrade relatively quickly at elevated temperatures, owing to Mn diffusion [3]. In this study, we investigated the effect of a new TiAl alloy film as under layer or capping layer on the thermal stability and interdiffusion befavior of top SVs at elevated temperatures. In addition, we compared the results in this instance with conventional Ta-based SVs. As shown in Fig. 1, when the samples were annealed at 300°C for 240 min, the MR ratio of the SV with TiAl capping increased 6 % (from 8.7 % to 9.3 %). By contrast, the MR ratio of the TiAl-underlayered and Ta-based SV decreased 31.8% (from 8.8 to 6.0%) and 42.2% (from 9 to 5.2%), respectively. We observed further enhancement in the MR ratio of TiAl-capped SV when the samples were annealed at 300°C for only 10 min. The TiAl capped SV possess superior thermal stability over traditional Ta-based SV because Mn did not diffuse into the active layers. By contrast, Mn diffused into the active layer such as pinned CoFe layer in the Ta-based SV. Due to high affinity of Ti or Al with oxygen, a very stable and dense TiAl-oxide was formed at the surface during annealing. It is well known fact that Mn is preferentially diffuse into the oxygen environment because of high chemical affinity between Mn and oxygen [3]. Therefore, as the surface TiAl-oxides provide the oxygen potential for Mn diffusion, Mn diffusion into the active layer such as CoFe layer was hampered. In addition, the MR ratio of the TiAl-capped SVs was higher than that of the TiAl-underlayered SVs. When the TiAl alloy was used as an underlayer, the (111) texture of the NiFe buffer film was underdeveloped compared to that of a Ta underlayer. We developed a SV with a high thermal stability, which demonstrates interdiffusion resistance at elevated temperatures, using a new TiAl alloy as a capping layer.

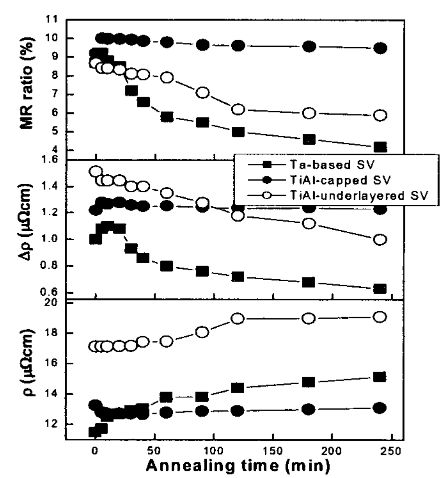

Fig 1. The magneto-resistive property changes of Ta- and TiAl-based SVs annealed at 300°C as a function of annealing time.

REFERENCES

[1] D. C. Parks, P. J Chen, W. F. Egelhoff, Jr., and Romel D. Gomez, J. Appl. Phys., **87**, 3023 (2000).

[2] T. Lin, and D. Mauri, Appl. Phys. Lett., **78**, 2181 (2001).

[3] H. G. Cho, Y. K. Kim, and S.-R. Lee, IEEE Trans. Magn., **38**, 2685 (2002); J. S. Kim, Y. K. Kim, S.-R. Lee, IEEE Trans. Magn., **39**, 2824 (2003); J. S. Kim and S.-R. Lee, phys. stat. sol. (a) **201**, 1743 (2004) E.-K. Hyun and S.-R. Lee, J. Mag. Mag. Matls. in printing, (2007).