Thermal stability and specular reflection of CoNbZr-based bottom spin valves with and without nano oxide layer

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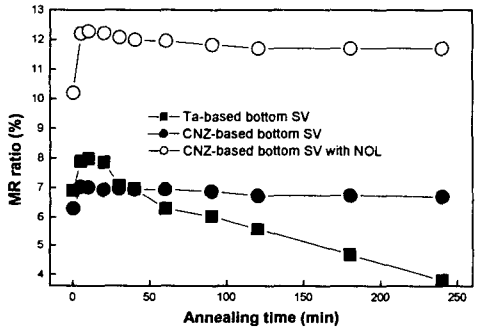
Spin valve (SV) with amorphous CoNbZr (CNZ) as under and capping layers instead of traditionally used Ta was proven to be very effective to improve surface uniformity and thermal stability [1]. In the present study, we investigated thermal stability and specularity aspects of the CNZ-based bottom SV with and without employing nano oxide layer (NOL) that was naturally oxidized. CNZ 2 (or Ta 5)/NiFe 2/IrMn 7.5/CoFe 1//NOL//CoFe 2/Cu 2.5/CoFe 3/CNZ 2 (or Ta 5) (nm) stacks were prepared by dc magnetron sputtering deposited on Si/SiO_2 substrates. As shown in Fig. 1, MR ratio of the as-deposited CNZ-based bottom SV increased 62 % (from 6.3 % to 10.2 %) with incorporating the NOL. The enhancement of MR ratio is considered to be due to the specular effect ($\Delta\rho$ increased from 0.722 μΩcm to 1.363 μΩcm) of the NOL. MR ratio of Ta-based bottom SV decreased about 45 % (from 6.9 % to 3.8 %) when the samples were annealed at 300 °C for 240 min. By contrast, MR ratio of CNZ-based bottom SV with and without NOL increased 14 % (from 10.2 % to 11.7 %) and 11 % (from 6.3 % to 7 %), respectively. The root mean square (RMS) roughness value of CNZ layer (0.07 nm) is superior to that of the Ta layer (0.43 nm). The CNZ-based bottom SV possess uniform interfaces and dense microstructure because of non-crystallinity and surface uniformity of the CNZ underlayer [1]. Interestingly, although Mn diffused out to the surface through the whole active layers resulting in the formation of Mn-oxide at surface in CNZ-based bottom SV (shown in Fig. 2), no trace of Mn was found in the active layers and no significant degradation has been occurred.



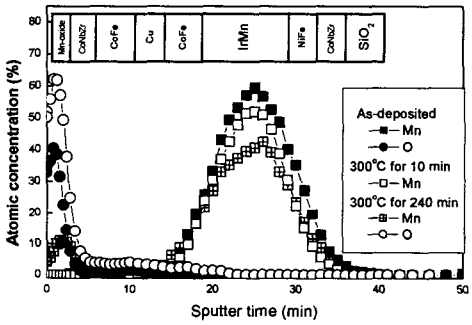


Fig. 1 MR ratio changes of Ta and CoNbZr-based bottom SV with and without NOL as a function of annealing time. Samples were annealed at 300℃.

Fig. 2 Auger depth profiles exhibiting Mn diffusion for a CoNbZr-based bottom SV film upon exposure to annealing at 300℃ for 10 and 240 min.

References

[1] Ho Gun Cho, Young Keun Kim, and Seong-Rae Lee, J. Appl. Phys., 91, 8581 (2002)