Reaction mechanism of chemical elements (Co, Fe, Mn) existing in spin valves containing oxide layers

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Abstract: On the basis of chemical properties of the elements (Mn, Fe, Co, etc.) contained in the pinned layers of spin valves (SVs) with oxide layers (OXLs), we attempted to clarify the effect of reaction mechanism of these elements on the thermal properties of SVs. The thermal degradation of MMn-based (M = Fe, Co, Ir, Pt, etc.) specular SVs at high temperatures (> 250°C) is thought to be caused by the diffusion of the Mn component in the structure. The role of Mn oxide as a diffusion barrier of Mn migration was clarified by the secondary-ion-mass spectroscopy (SIMS) and X-ray photoelectron spectroscopy (XPS) depth profile analyses. Mn diffusion in the free layer was inhibited at up to 300°C in a SV with an OXL, where MnO formation occurs in the OXL, which is confirmed by the MnO $2p_{3/2}$ and $2p_{1/2}$ peaks. As Mn diffused from FeMn (without an OXL), there appeared to be no significant oxide formation in the pinned layer. The details of the possible reaction mechanism concerning the chemical elements that exist in the OXLs can be understood by utilizing the standard Gibbs free energy change (ΔG°) as a function of temperature for all chemical elements (Co, Fe, Mn, etc.).
Author Keywords: Diffusion barrier; GMR; Specular spin valve; Thermal stability
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