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Chemical analysis of ultrathin oxide layer in a specular spin valves

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Spin valves with specularly ultrathin oxide layers are promising owing to their improved properties such as strong thermal stability, large exchange bias, and good MR response. A few studies about an oxidation process and a microstructure of the ultrathin oxide layer have been attempted. However, chemical microstructures of the oxide layer are not fully understood yet. We investigated a relationship between MR performance and chemical states of Co and Fe in the specularly reflective oxide layer of spin valves by Near-Edge X-Ray Absorption Fine Structure (NEXAFS) spectrometry. The spin valve structure was Si/Ta 50/NiFe 20/IrMn 60/CoFe 15/oxygen exposure/CoFe 15/Cu 25/CoFe 20/NiFe 20/Cu 10/Ta 50 (Å). Our close examination of the NEXAFS spectra and the GMR responses of the spin valve with a partially oxidized CoFe layer manifests that (1) the local potential at Fe oxides can provide high specularity and this results in a high GMR value, (2) a small amount of Co oxide can also help improve both MR response and magnetic properties, and (3) the stable phases like α-Fe_2O_3 and CoO can improve MR performance further probably due to relatively high potentials. We also confirmed that oxygen preferred to bond with the solute Fe rather than the solvent Co of the Co90Fe10 magnetic layer. Obtaining appropriate oxide phases is the key to optimizing MR responses and magnetic properties of a spin valve with specularly reflective oxide layers. In this presentation, we clarify and identify chemical fine structures of the specularly reflective ultrathin oxide layer of spin valves.