# Ir/Coを用いた垂直磁化MTJの作製

## Fabrication of a perpendicular-MTJ by utilizing an Ir/Co stack

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Developing larger interfacial perpendicular magnetic anisotropy (i-PMA) has been an urgent issue for realizing higher scalability of STT-MRAMs. Although, the 30-nm technology node has almost been satisfied by employing i-PMA at the CoFeB/MgO interface, optimism about developing the next generation of STT-MRAMs is not high. Differing from ordinary approaches such as finding a higher i-PMA in the CoFeB/MgO system, we attempted to achieve high i-PMA by merging two i-PMA at both cobalt-on-iridium (Ir/Co) and CoFeB/MgO interface. So far, i-PMA in noble-metal / Co systems has been studied quite extensively. The study of Ir/Co pointed out that from an extrapolated plot of the i-PMA characteristic, PMA would ideally reach 1.5 erg/cm$^2$ (which is larger than that of a widely used Pt/Co interface) [1)]. However, an actual Ir/Co sample exhibited PMA of no more than 0.2 erg/cm$^2$ at a finite Co thickness due to intermixing at the interface. In this study, an Ir/Co-based stacking structure with large i-PMA was carefully fabricated, then the Ir/Co stack was integrated into a free-layer structure of a practical p-MTJ to realize a highly scalable STT-MRAM [2)].

Films were deposited at room temperature by using a sputtering apparatus. During the deposition process, the deposition rate of the Co layer was reduced to less than 0.02 nm/s to suppress any intermixing of Ir and Co at the Ir/Co interface. First, i-PMA in Co/Ir based multilayers was evaluated. TEM image revealed that the Co layer was clearly identified as an hcp (0001)-orientated layer formed on the Ir buffer layer. The i-PMA index ($K_{\mathrm{eff}}t$ product) was up to 0.72 erg/cm$^2$ for $t$ = 0.7 nm, which is three times larger than that obtained in a previous study thanks to the weak interfacial mixing. Then the free layer structure consisting of Ta (5.0)/ Ru (3.0)/ Ir (7.0)/ Co ($t_{\mathrm{Co}}$)/ W (0.2)/ FeB (1.0)/ MgO (1.1) was fabricated. The largest $K_{\mathrm{eff}}t$ product (0.9 erg/cm$^2$) is obtained for the sample with $t_{\mathrm{Co}}$ = 0.8 nm (i.e., free layer thickness of 2.0 nm) annealed at 260ºC. It satisfies Δ as large as 60 when p-MTJ diameter is more than 19.3 nm. Finally, a bottom-free p-MTJ consisting of a free-layer structure mentioned above was fabricated. While high PMA was retained, high MR ratio (100%) and low RA product (3.0 Ωμm$^2$) were achieved. Such plural origins of PMA, high MR ratio and low RA product would open up a novel strategy to realize a highly scalable STT-MRAM beyond the 20-nm technology node.

References:

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