# CoFeSiB Thickness Dependence of Magnetic Field Sensor Performance in Magnetic Tunnel Junctions

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Magnetic field sensors based on magnetic tunnel junctions (MTJs) are promising candidate to replace SQUID because of small size, low power consumption, and room temperature operation. High signal (≅ sensitivity: TMR ratio/2$H_k$, $H_k$: magnetic anisotropy field) and noise ratio (SN ratio) is required for measurement of bio-magnetic field ($10^{-6}$ – $10^{-11}$ Oe). In previous works, although the sensitivity was improved by increasing CoFeSiB thickness [1], the noise property was not investigated. In this study, we systematically investigated the CoFeSiB thickness dependence of sensor performance in MTJs.

The films were deposited onto thermally oxidized Si wafers using an ultra-high-vacuum magnetron sputtering system ($P_{base}$ < 2.0 x $10^{-6}$ Pa). The stacking structures of the MTJ films were Si, $SiO_2$ subs. /Ta 5 /CoFeSiB 30, 70, 100, 200/Ru 0.4/CoFeB 3/MgO 1.7/CoFeB 3 /Ru 0.8 /CoFe 5/IrMn 10/Ta 5/Ru 8 nm. The MTJs were annealed at 350°C for 1 hour in a vacuum. The MTJs were annealed again for 15 min in the atmosphere to obtain MTJs with orthogonal magnetic easy axis of free and pinned layers. The TMR properties were measured by the DC four-probe method. The signal voltage at AC magnetic field (3.3 Hz, $H_{PTP}$=0.2 Oe) and the noise voltage were measured by bridge circuit at frequency of 0.1 Hz – 10 Hz.

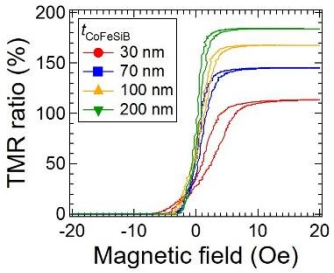


Fig. 1 TMR curves in MTJs with CoFeSiB electrodess

Fig. 1 shows the magneto-resistance curves in MTJs with various CoFeSiB thickness. The sensitivity was improved by increasing CoFeSiB thickness because of both reduction of $H_k$ and increase of TMR ratio. Fig. 2 shows CoFeSiB thickness dependence of the SN ratio which is defined as (signal voltage)/(noise voltage) and detectivity which is defined as ($H_{PTP}$=0.2 Oe)/(SN ratio). Both SN ratio and detectivity were improved by increasing CoFeSiB thickness. A very high detectivity of ca. 2×$10^{-4}$ Oe was successfully achieved in MTJs with CoFeSiB thickness of 200 nm.

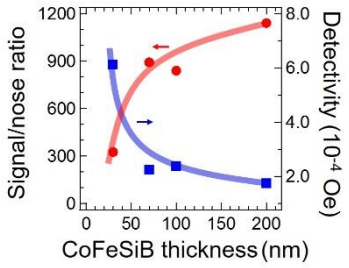


Fig. 2 CoFeSiB thickness dependence of SN ratio and detectivity

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