

Tunnel Magnetoresistance Effect in Magnetic Tunnel Junctions using Perpendicularly Magnetized [Co₇₅Fe₂₅/Pd] Multilayer

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Spin-torque-oscillators with perpendicularly magnetized free layer (PMF-STOs) have attracted much attention toward the applications in nanometer-size high-frequency wave devices [1]. Recently, frequency resources in microwave band are becoming tight, and demand for millimeter wave is increasing. Co-based multilayers and $L1_0$ ordered alloys are one of the promising materials to realize the operation of PMF-STOs in millimeter wave band, because they exhibit large perpendicular magnetic anisotropy (PMA) [2]. In this study, toward the application of PMF-STOs which can be operated in millimeter wave band, we fabricated magnetic tunnel junctions (MTJs) using [Co₇₅Fe₂₅/Pd] multilayer and evaluated the magnetoresistance properties.

The films consisting of buffer layers/[Co₇₅Fe₂₅(0.2)/Pd(0.8)]₄/Co₅₀Fe₅₀(0.5)/MgO(0.7)/Co₄₀Fe₄₀B₂₀(3)/Ru(0.85)/Co₇₅Fe₂₅(5)/IrMn(10)/capping layers (in nm) were deposited on thermally oxidized Si substrate by UHV magnetron sputtering. They were micro-fabricated into small junction with diameter ϕ of 160 nm by using electron beam lithography and Ar ion milling. Magnetoresistance properties were measured by DC two-probe-method at room temperature.

From the magnetization curves of [Co₇₅Fe₂₅/Pd]/Co₅₀Fe₅₀ multilayer, it was found that [Co₇₅Fe₂₅/Pd]₄/Co₅₀Fe₅₀ multilayer was perpendicularly magnetized. Perpendicular magnetic anisotropy constant (K_u) was about 5.7 Merg/cm³ and the expected frequency is in millimeter wave band. TMR curves when magnetic field was applied perpendicular to the film plane were shown in Fig.1. TMR curves indicating the PMA of [Co₇₅Fe₂₅/Pd]/Co₅₀Fe₅₀ and in-plane magnetized reference layer was observed. TMR ratio and resistance were about 1.6% and 181 Ω (ϕ = 160 nm), respectively. These results shows it was succeeded to fabricate low-resistance MTJs which could be used as PMF-STOs in millimeter wave band.

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[1] H. Kubota *et al*, Appl. Phys. Exp. **6**, 103003 (2013) [2] P. F. Carcia, J. Appl. Phys. **63**, 5066(1988)

[3] K. Hatakeyama *et al*, 73th JSAP, 11p-PA2-1

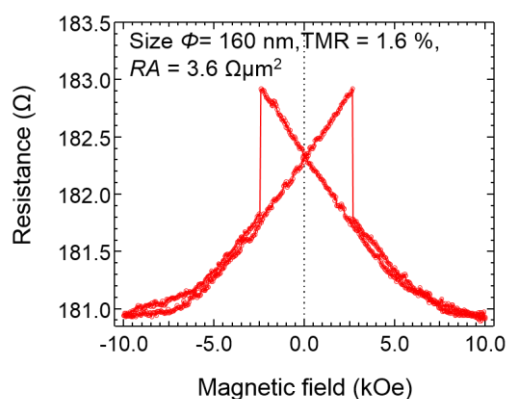


Fig.1 TMR curves for MTJs with Co₇₅Fe₂₅/Pd/Co₅₀Fe₅₀ multilayer