

MgO-based magnetic tunnel junctions with a synthetic free layer consisting of CoFeB/Ru/Ni trilayer

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1. 서론

The spin-transfer switching in magnetic tunnel junctions (MTJs) with synthetic ferrimagnetic (SyF) free layers has attracted much interest because it can provide both a large thermal stability and a reduction of switching current densities[1]. For example, a recent theoretical study has reported that a large thermal stability approximately four times larger than that of a single free layer is expected when the coupling strength is close to the uni-axial anisotropy energy [1]. In this regard, a CoFeB layer coupled with materials having small magnetic anisotropy and small magnetization like Ni is an interesting system to study the relationship between intrinsic factors such as the spin torque efficiency and magnetic coupling.

2. 실험방법

We have fabricated nano-sized MTJs with synthetic ferrimagnetic free layers consisting of substrate/ Ta (5)/ CuN (30)/ Ta (5) / PtMn (20)/ CoFe (3)/ Ru (5) / MgO (1.1)/ Co₆Fe₂B₂ (2)/ Ru (t_{Ru})/ FM (2)/ CuN (10)/ Ru (7) (thickness in nm). The MTJs were fabricated by electron beam lithography and Ar ion milling. The magnetic properties were measured using a vibrating sample magnetometer (VSM), and the tunnel magnetoresistance (TMR) properties were measured using a 4-probe method at room temperature. To observe the switching probability owing to current induced magnetization switching (CIMS)[1], dc pulses of 300 ms were applied to the MTJs, and then the switching characteristics were investigated.

3. 실험결과 및 고찰

The CoFeB /Ru /Ni trilayers after annealing at 270⁰C show almost ferromagnetic couplings between two FM layers over a wide range of the Ru thickness. Only the MTJ full stack having a 0.7-nm-thick Ru interlayer shows a weak anti-ferromagnetic coupling.

The MTJ having CoFeB (2nm)/ Ru (1.3nm)/ Ni (2nm) F-coupled synthetic free layer showed a reasonable switching current density and an enhanced thermal stability in comparison with the MTJs with a single free layer. This result proves useful in designing the MTJs with a SyF free layer for applications.

4. 참고문헌

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