Influence of the structure of ferromagnetic bottom electrode on electron transport in magnetic tunnel junctions

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We obtained remarkably improved properties in the bias voltage dependence of tunneling magnetoresistance (TMR) by using an epitaxial NiFe bottom electrode. The epitaxial $Ni_{80}Fe_{20}(111)$ layer was sputtered on Si(111) substrate with a Ag/Cu buffer layer. The Si substrate was etched in 40% NH_4F solution to remove a native oxide layer and obtain atomically flat surface with hydrogen-terminated structure. An insulating layer was prepared using plasma oxidation of an Al film surface. A top electrode was a multilayer of CoFe/IrMn/NiFe/Ta. All the layers were prepared without breaking vacuum. The multilayer film was patterned into magnetic tunnel junctions (MTJs) by micro-fabrication method including photolithography and Ar ion milling. The surface structure of the substrate and each layer was investigated by LEED, STM and conducting AFM. Rocking curve and ϕ-scan measurements of XRD were additionally performed to specify crystallographic structure such as degree of texture. After annealing, the MTJs showed TMR ratios over 50% and V_{half}, a bias voltage at which TMR reduces to half of the maximum value, increased up to 750 mV. Consequently, we obtained large output signal of about 200 mV (Fig.1). Inelastic electron tunnel spectroscopy was used to analyse electron tunneling through the interface between the ferromagnetic electrodes and the tunnel barrier. It was found that the number of trap sites for electron tunneling is smaller than that of MTJs with non-epitaxial ferromagnetic electrodes [1].

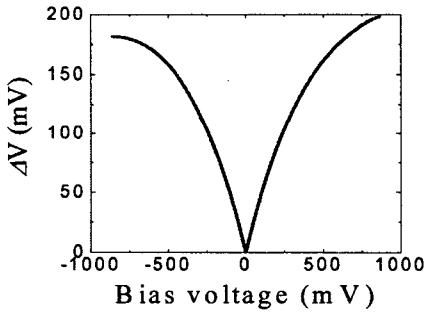

Fig.1. Output signal of MTJ with epitaxial NiFe bottom electrode.

References

[1] J. H. Yu, Y. Ando, T. Miyazaki, and H. M. Lee, Appl. Phys. Lett. 82, 4735 (2003).