

Origin of Junction Area Dependence on Naturally Oxidized Spin-Dependent Tunneling Junction

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자연산화법으로 제작된 스핀의존터널링 접합의 접합면적 의존성

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The low resistance spin-dependent tunneling (SDT) junctions having area dependence were grown the structure, Si-substrate/Ta/NiFe/Ta/NiFe/FeMn/CoFe/Al₂O₃/CoFe/NiFe. Figure 1 shows an optical microscope picture of the junction (Fig. 1). The bottom-type TMR multilayer films with a structure of Ta5/NiFe10/Ta5/NiFe10/FeMn10/NiFe2/CoFe2 /Al₂O₃1/CoFe3/NiFe20 (thickness in nm) were deposited by ion beam and magnetron sputtering system with base pressure of 10⁻⁹ Torr. The Al₂O₃ formed by 20 min *in situ* natural oxidation without any vacuum break. Fig.2 shows the typical MH and TMR curves for the naturally oxidized SDT junction.

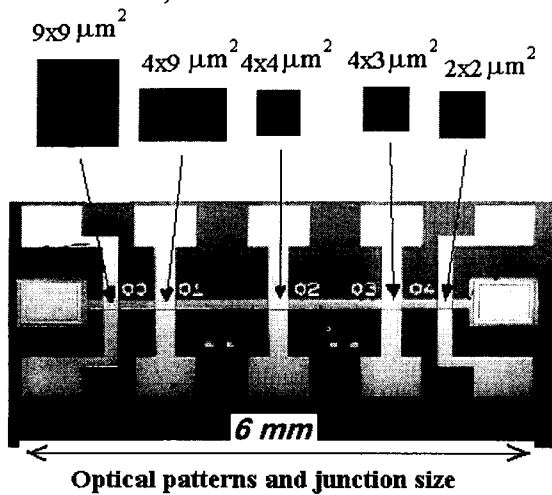


Fig. 1 Optical microscope picture of the junction

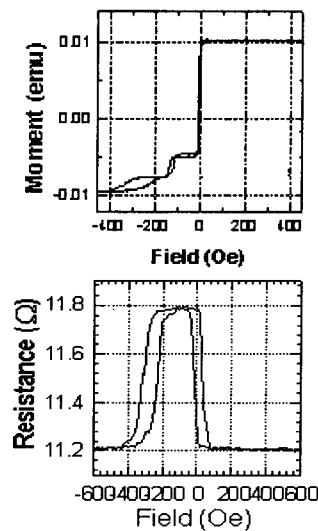


Fig. 2 Typical MH and TMR Curves

Fig. 3 shows that junction tunneling magnetoresistance (TMR) and junction resistance area product increased up to 18% and decreased down to 80 ohm-micron square as the junction size decreased from 80 to 4 μm², respectively.

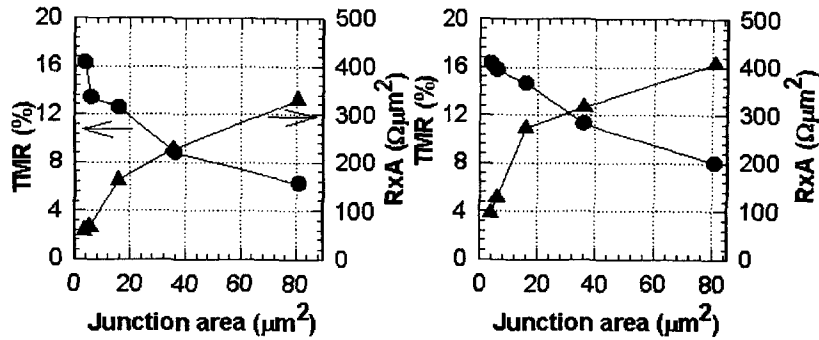


Fig. 3. Dependence of junction tunneling magnetoresistance (TMR) versus junction resistance area product.

We used cross sectional high resolution transmission electron microscopy (HRTEM) to observe the naturally oxidized Al_2O_3 barriers directly, respectively. The barrier Al_2O_3 thickness was uniformly covered in the range of 1.0-1.3 nm without pinholes and

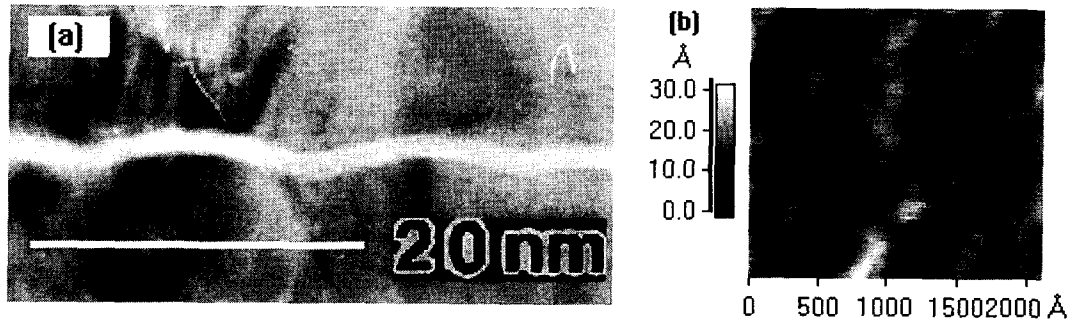


Fig. 4. (a) HRTEM picture and (b) AFM images for the naturally oxidized SDT junction.

waveform having 1 nm of height and 10 of width was indicated at HRTEM pictures (Fig. 4a). This amplitude of wave did accord with one of peak to valley from line analysis in atomic force microscopy (AFM) images and was 1.5 times larger than DC plasma oxidation barrier without area dependence[1]. It may be implied that the junction area dependence of TMR properties was dominantly due to interface roughness of barrier more than other various origins, such as large sheet resistance, channeling effect, and magnetization reverse process in small junction size[2,3,4].

References

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