Local Current Distribution of Ferromagnetic Tunnel Junction Fabricated with Microwave-Excited Plasma

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In order to make magnetic tunnel junctions (MTJs) applicable as magnetoresistive reading head and non-volatile magnetoresistive random access memories (MRAMs), high TMR ratio and low resistance of MTJs are very essential. We have been reported the MR ratio of 60 % at room temperature in MTJs fabricated by microwave-excited plasma. In this article, MTJs with Al-O and Al-N layer were fabricated by microwave-excited $Ar+O_2$ and $Ar+N_2$ plasma, respectively. The effect of annealing temperature on the local transport properties of MTJs was studied using conductive Atomic Force Microscopy (AFM). Fig. Shows the current distributions determined from the electrical current image for MTJs with Al-N layer and the results fitted by the Gaussian distribution of local barrier height. After annealing at 300°C, where the TMR ratio of the corresponding MTJ reaches the maximum value of 35 %, the average barrier height (Φ_{ave}) is 2.04 eV and its standard deviation (σ_Φ) is 0.2 eV. After further annealing at 340°C, the standard deviation (σ_Φ) increases to 0.3 eV. Also, the experimental current distribution is asymmetric and deviates from the best-fitted histogram at the high current region. This result means the generation of the low barrier height region that results in the leakage current. In order to obtain the high tunnel magnetoresistance (TMR) ratio, the increase of the average barrier height (Φ_{ave}) and the decrease of the barrier height fluctuation must be strictly controlled.

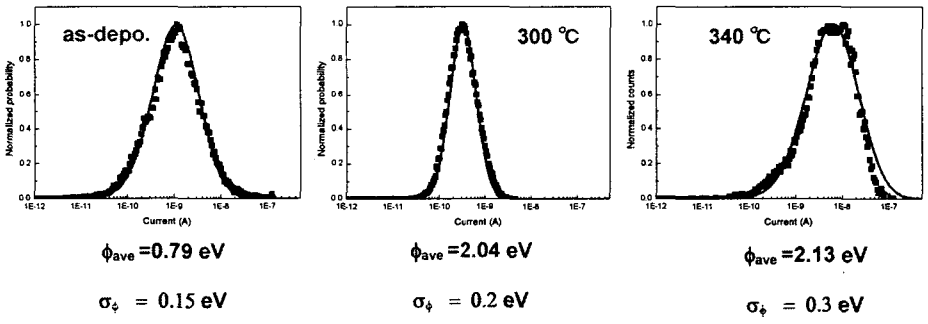

Fig. Current distribution statistically calculated from the electrical current images is indicated by squares. Solid lines are the fitting results considering the Gaussian distribution of barrier height for the junction annealed at various temperatures.

References

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[2] Tae-Sick Yoon et al., Korean Journal of Materials Research, Vol. 13, No.4, (2003) p.233-238.