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Improved Thermal Stability of Mn-Ir Based Magnetic Tunnel Junction with Nano Oxide Layer

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Magnetic tunnel junctions (MTSs) have been largely researched due to there potential application as non-volatile magnetic random access memory (MRAM) cell and magnetic read head. For MRAM fabrication, integration with the complementary metal-oxide-semiconductor device is needed. This process requires post-annealing up to 450 ℃ to healing transistor damage by inducing plasma processing. The traditional MTJ is consisted of substrate/buffer/AFM/FM/Al_2O_3/FM/capping, where AFM is antiferromagnetic layer (Mn based metallic layer), and FM is Co-Fe or Ni-Fe/Co-Fe. But above 300 ℃, TMR signal usually decreases due to polarization loss resulting from Mn diffused from AFM or change of barrier [1]. Our previous results showed that nano oxide layer (NOL) in pinned layer acts as a diffusion barrier of Mn in GMR specular spin valve multilayer [2]. In this study, we tried to improve thermal stability of MTJ by substituting Co-Fe/NOL/Co-Fe for Co-Fe pinned layer.

Specular-MTJ of Si/SiO2/Ta 5/Ni-Fe 7/Mn-Ir 6/Co-Fe 2/NOL/Co-Fe 2/Al 2- oxidation/Co-Fe 2/Ni-Fe 7/Ta 5 with and without NOL multilayer were deposited by magnetron process, where thickness is nm. Junctions were patterned by a set of metal shadow mask with an area 200 × 200 ㎛. NOL was formed in the load lock chamber by exposing to pure oxygen gas. Samples were annealed for 30 min. at range from 40 to 440 ℃ under 3 kOe in-plane magnetic field in a vacuum furnace. The two point method was used for measuring TMR and the I-V curves at room temperature. Barrier height and width were derived from fitting I-V curves to the Simmons equation.

For without NOL, TMR ratio was increased from 11.9 to 21.6 % until 300 ℃ and decreased abruptly. At 410 %, TMR ratio exhibited zero. On the other hand, for with NOL, TMR ratio was increased from 11 to 22.7 % until 410 ℃ and decreased slowly. At 440 ℃, TMR ratio exhibited about 6 %. These result indicated that NOL in pinned layer acts as a diffusion barrier of Mn. The bias dependence was improved by annealing at each optimal temperature in both samples. More detailed magnetic and electrical properties with and without NOL as a function of annealing temperature will be presented in conference site.

References

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