RC13

Electrical Breakdown of Co /AlOx /Co Tunnelling Junction

K. Horikiri* and **K. Shiiki**

Department of Applied Physics and Physico-Informatics, Keio University, Yokohama 223-8522, Japan

*Corresponding author: horik@appi.keio.ac.jp. Phone: +81-45-566-1601, Fax: +81-45-566-1587

Magnetic tunnelling junctions (MTJs) are an attractive candidate for future magnetic heads, magnetic field sensors and magnetoresistive random access memories (MRAMs).However, it is known that MTJs sometimes electrically break down even at low voltages by a voltage stress. The mechanism of the electrical breakdown is not clarified yet.

Tunnellingjunctions which consist of Co (10 nm) /AlOx /Co"@(50 nm) were fabricated on a glass substrate using metal mask by ion-beam sputtering. After the Al layer 2.5 nm thick was deposited, the insulator AlOx was formed by thermal oxidation in pure O_2. The electrical properties of the junction were measured by the four probe method. The breakdown phenomena were studied by constant voltage tests. On the constant voltage test, the change in the barrier height and the uniformity was estimated by fitting the I-V characteristics to two potential model [1] at every half hour.

Fig. 1 and Fig. 2 show electrical breakdown phenomena of junctions at applied voltage of 0.6 V, which have homogeneous barrier and inhomogeneous barrier, respectively. As shown in Fig. 1, the tunnel resistance hardly changed after the voltage was applied. After 68hours, the tunnel resistance decreased sharply. On the other hand, Fig. 2 shows that the tunnel resistance decreased after the voltage was applied and the tunnel resistance decreased sharply after 21 hours. For the junctions withinhomogeneous barrier, the average of life"@time was 50.7 hours, which was earlier than 86.3 hours of the average for junctions withhomogeneous barrier. In the breakdown process, the homogeneous barrier became inhomogeneous gradually, just before the breakdown. It is thought that the junctions with inhomogeneous barrier were easily broken.

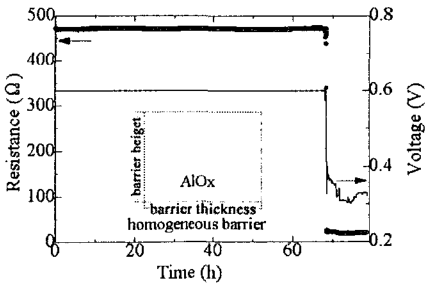

Fig. 1. Time dependence of tunnel resistance (homogeneous barrier).

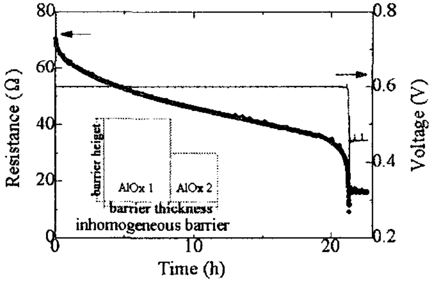

Fig. 2. Time dependence of tunnel resistance (inhomogeneous barrier).

REFERENCES

[1] N. Arakawa, Y. Otaka, and K. Shiiki : Thin Solid Films. 505 (2006) 67.

RC14

Magnetic and Thermal Properties of Spin Valves Having Various Underlayers Deposited Directly on Top of Si Substrates

Jiwon Kim[1], **and Soonchul Jo***[1]

[1]School of Electronic Engineering, Soongsil University, 1 Sangdo-Dong, Dongjak-Gu, Seoul 156-743, Korea

*Corresponding author: jschul@ssu.ac.kr, Phone: +82 2 820 0636, Fax: +82 2 821 7653

Magnetic and thermal properties of spin valves having Ta(N) and Mo(N) underlayers were studied by depositing the underlayers directly on top of Si substrates. Spin valve structures of Underlayer(35 Å)/NiFe(21 Å)/CoFe(28 Å)/Cu(22 Å)/CoFe(18 Å)/IrMn(65 Å)/Ta(25 Å) were deposited on the Si substrates by using DC magnetron sputtering system. Underlayer materials studied were Mo, MoN, Ta, and TaN. Nitrogen flow rate during the nitride deposition was 1 sccm. Annealing of the spin valves were performed from 200 to 350 °C for 60 min. each sequentially at a pressure of 5 × 10^{-4} Torr in a magnetic field of 2 kOe.

Figure 1 shows the MR ratio of spin valve structures for various underlayer materials as a function of annealing temperature. The highest MR ratio of the spin valve structure was obtained using TaN underlayer. The MR ratio was increased from the as-deposited value of 7.3 % to 8.3 % at the annealing temperature of 200 °C, then gradually decreased to 6.0 % at 320 °C. After annealing at 350 °C, the MR ratio was decreased to below 1 %. Spin valve structure having Ta underlayer showed similar annealing behavior,but at considerably lower MR ratio, which has well been documented in other publications. When the underlayer was MoN film, the as-grown MR ratio was 5.3 % and the MR ratio was decreased rapidly down to 3.1 % after annealing at 200 °C. The MR ratio for Mounderlayer was the lowest. As-grown MR ratio was 2.1 % and the MR ratio was decreased to almost zero after anneling at 250 °C.

From the data presented here, it is concluded that it is advantageous to use TaN underlayer if one wants to fabricate spin valves directly on top of Si substrate. Also, it is to be noted that TaN may be used as a diffusion barrier between the substrate and ensuing active spin valve layers.

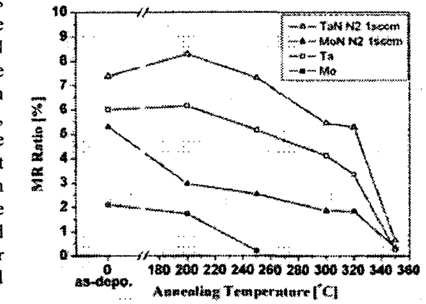

Fig.1. MR ratio of spin valve structures for various underlayer material as a

REFERENCES

[1] B. Dieny, V. S. Speriosu, S. Metin, S. S. Parkin, B. A. Gurney, P. Baumgart, and D. R. Wilhoit, j. appl. phys., **69**, 8 (1991).

[2] J. Kim, Y. Choi, S. Jo, S.Y. Kim, and C.W. Lee, IEEE Trans. Magnetics, **42**,10(2006).