Comparison of magnetic tunnel junctions with Al-oxide, Hf-oxide, and Ce-oxide barriers

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The properties of magnetic tunnel junctions (MTJ's) with aluminum oxide, hafnium oxide, or cerium oxide barriers are compared. When aluminium, cerium, or hafnium are deposited by ion beam sputtering, an exposed time of 10 min using by electron cyclotron oxygen ion plasma is sufficient to completely transform the deposited Al, Hf, or Ce films from pure metals to oxide barriers. We have investigated the voltage bias dependence the tunneling magnetoresistance (TMR) of three oxide barriers. The TMR and half bias voltage (V_h) values for three MTJ's with different oxide tunnel barriers (Al_2O_3, HfO_x, and CeO_2) are 400 mV, 20%, 600 mV, 18%, and 700 mV, 16%, respectively. This implies that the polarization of CoFe contacted with Ce oxide, Hf oxide, or Al oxide is almost same. Figure 1 shows the magnetic properties of MTJ with Al_2O_3 tunnel barrier. As HfO_x and CeO_2 layers are replaced instead of Al_2O_3, the MTJ stability with a high V_h is restored. The high MTJ's stabilities can be thought due to the superior surface uniformity and fine microstructure. The detailed analysis of interface between tunnel barriers and ferromagnetic layers will be achieved by high resolution tunneling microscope (HRTEM).

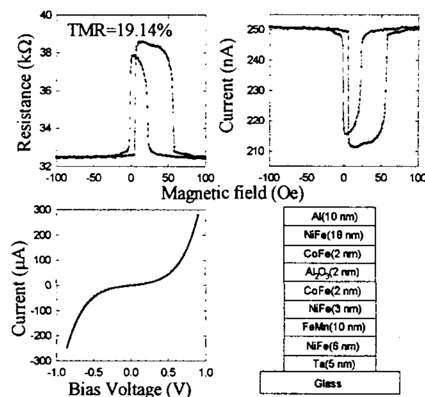

Fig. 1. The TMR, tunneling current, and $I(V)$ curves measured at RT for Ta(5)/NiFe(6)/FeMn(10)/NiFe (3)/CoFe(2)/Al_2O_3(2)/CoFe(2)/NiFe(18)/Ta(5) (nm) as deposited ($RA=1\times10^9$ $\Omega\mu m^2$), and the layer structure of a magnetic tunnel junction (MTJ).

References

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