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Inelastic electron tunneling spectroscopy of MgO barriers

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Abstract

Recent development in TMR junction with MgO barrier attracts a great deal of attention. It is reported that the junctions with MgO barrier exhibit higher TMR with lower RA value. Even the spin-transfer torque phenomenon has been demonstrated, strongly suggesting that the future MRAM architecture will have to incorporate the MgO barrier TMR junctions with the spin-transfer torque mechansim. The device parameters for MRAM will require the RA value of about 100 $\Omega-\mu m^2$, corresponding to about 1 nm thick MgO barrier layer. In order to understand the electrical properties of MgO barrier, we have fabricated Mg/MgO/Mg tunneling junctions as the function of oxidation time of the Mg metal layer. These Mg/MgO/Mg cross-strip junctions are deposited using stencil mask without vacuum break, and the size of junction area is about 130 μm by 160 μm. When measuring d^2I/dV^2-V, namely the inelastic tunneling spectroscopy, we observed the peaks correponding to MgO bonds, indicating that the MgO barrier is a stable and good insulator. Using the IETS measurement technique, we will investigate the interface properties between the ferromagnetic electrode and the MgO barrier layer. For the low RA value junctions, we will report on our use of Nb superconducting electrodes under and over the Mg layer to abolish the current crowding problem for our relatively large junctions. Moreover, we will report on our MgO_xF_y tunnel barrier using our fluorine doping method as an effort to control the oxidation of less than 1 nm thick Mg metal layer.