Property Optimization of MgO Tunnel Barrier at Various Annealing Conditions

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To achieve a high tunneling magnetoresistance (TMR) of sputtered magnetic tunnel junctions (MTJs) with an MgO barrier, the annealing process is indispensable. The structural and compositional changes as consequences of the annealing greatly affect the spin-dependent transport properties of MTJs. Higher TMR could be obtained for MTJs annealed at higher annealing temperature, however, diffusion of Ru, Mn and/or Ta in the MTJs may occur during annealing process is known to be detrimental to spin-dependent tunneling effect. The rapid thermal annealing (RTA) process was used for annealing the MTJs with synthetic antiferromagnets. To determine whether the diffusion of Mn, Ru and/or Ta in the MTJs can be suppressed the systematic investigation of RTA effects on the properties of MTJs by minute controlling the process time and temperature is addressed. A significant change in TMR value and barrier parameters occurs within 10 sec during RTA. The dependence of TMR on annealing time and temperature provides the information about crystallization of electrodes and diffusion processes occurred in MTJs. The structural and compositional analyses were also performed to clarify the effect of annealing on the properties of MTJs.