Intensified Magneto-Resistance by Rapid Thermal Annealing in Magnetite (Fe_3O_4) Thin Film on SiO_2 Glass Substrate

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We have observed large magneto-resistance (MR) intensified by rapid thermal annealing (RTA) in magnetite (Fe_3O_4) thin film (MTF) on SiO_2 glass substrate. The MTF was produced by the RF magnetron sputtering method (RF-MSM). The electrical resistivity (ER) of as-grown MTF's (AG-MTF's) showed the Mott's variable range hopping behavior, which indicates that AG-MTF's are amorphous-like. Although the MR ratio of bulk single crystal of magnetite is very small except around the Verwey transition temperature (VTT), that of AG-MTF's is moderately large below room temperature. Due to the RTA of AG-MTF's using the infrared image furnace, the MR ratios of MTF's were drastically enhanced, especially by the annealing around the Curie point (585°C). Furthermore the ER of MTF's treated by RTA (RTA-MTF's) showed a jump around the VTT, which implies the high crystallinity of RTA-MTF's. The MTF's made by the RF-MSM are composed of nano-sized magnetite particles (NMP's). By the RTA of MTF's around the Curie point, the magnetic moments of NMP's are mutually randomized . As a result, the MR ratios of MTF's are drastically increased by the RTA, on the spin dependent scattering.