Temperature Effect of Exchange Coupling in MnIr/ CoFe/AlO_x/CoFe/NiFe Magnetic Tunnel Junctions

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Magnetic tunnel junctions (MTJs), due to the potential application in MRAM (magnetic random access memory), have been paid much attention since 1995[1,2]. Enlarging the exchange bias field and optimizing the structure have been the focus that many researchers studied. In this report, magnetic properties of MTJs with structure of Si/Ta (50 Å)/ Cu (100 Å)/ Ta (50 Å)/ $Ni_{80}Fe_{20}$ (20 Å)/ Cu (50 Å)/ $Mn_{75}Ir_{25}$ (100 Å)/ $Co_{70}Fe_{30}$ (25 Å)/ Al-O (15 Å)/ $Co_{70}Fe_{30}$ (25 Å)/ $Ni_{80}Fe_{20}$ (t Å)/ Ta (50 Å) (t=0, 100 and 1000, respectively) were investigated. The temperature dependence of exchange coupling was considered. The measurement of the magnetization curves below room temperature was carried out using SQUID (Superconducting Quantum Interference Device) magnetometer; and temperature dependence of exchange coupling, derived from MR curve, was investigated in the cryogenic chamber. The crystalline structure was examined by X-ray diffraction. In the case of these samples, the exchange bias energy is almost inversely proportional to temperature. XRD shows the improvement of (111) texture of IrMn and Cu after annealing. Taking account of the pinned layer, the exchange bias field decreases with the increasing temperature due to thermal effect. And the exchange bias is the highest for t= 100 Å sample due to the best [111] texture and increased crystallite size of $IrMn_3$ after annealing[3].However, the variation of coercivity (H_c) is similar to that of the exchange field for free layer.

References

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