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Fabrication of $Fe_3O_4/Al_2O_3/Fe$ and $Fe_3O_4/CoCr_2O_4/Fe$ tunnel junctions

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【Introduction】In recent electronics industry, the spintronics is a crucial technique which evolves the memories from volatile to non-volatile. In order to realize the high-density non-volatile memory, it is necessary to develop a material which has a high spin polarization. Magnetite(Fe_3O_4) is a half-metallic ferromagnetic material, which has 100% spin-polarization, with a high Curie temperature of 860K [1]. However, the large magnetoresistance expected from high spin polarization of Fe_3O_4 has not been obtained [2]. In this study, we fabricated high-quality Fe_3O_4 epitaxial film and the tunnel junction films which have a barrier layer of Al_2O_3 or $CoCr_2O_4$. $CoCr_2O_4$ has a spinel structure and the lattice parameter is almost same as Fe_3O_4 [3].

【Experiment】Samples were fabricated by an MBE system. The sample structures were MgO(001) or MgO(110) substrate / MgO / Fe_3O_4 / Al_2O_3 / Fe, MgO(001) or MgO(110) / Fe_3O_4 / $CoCr_2O_4$ / Fe. The Fe_3O_4 film was formed by reactive deposition at a T_{sub} of 300℃ in an O_2 atmosphere. Then annealed at a T_a of 600℃ for 30 minutes in an O_2 atmosphere. Partial pressure of O_2 was 4×10^{-4}Pa. $CoCr_2O_4$ thin film on the Fe_3O_4(100) was formed at a T_{sub} from 60℃ to 400℃. The epitaxial growth and the surface structure were observed by RHEED and AFM.

【Results】As shown in Fig.1, the RHEED pattern of Fe_3O_4(100) showed a clear streak pattern and Laue rings were observed. The surface roughness, R_a, was estimated 0.12nm by AFM measurement. Therefore, the Fe_3O_4(100) layer was considered to be a high-quality and flat epitaxial film. With respect to magnetic properties, clear magnetic hysteresis curves were obtained by M-H measurements at room temperature. Fig.2 shows the RHEED pattern of $CoCr_2O_4$ barrier grown on Fe_3O_4(100). After reactive deposition at a T_{sub} of 400℃ in an O_2 atmosphere, the $CoCr_2O_4$ film was annealed at a T_a of 400℃ for 3 minutes in the O_2 radical atmosphere. The pattern of $CoCr_2O_4$(100) showed clear streak pattern. The surface roughness Ra was 0.23nm.

【References】

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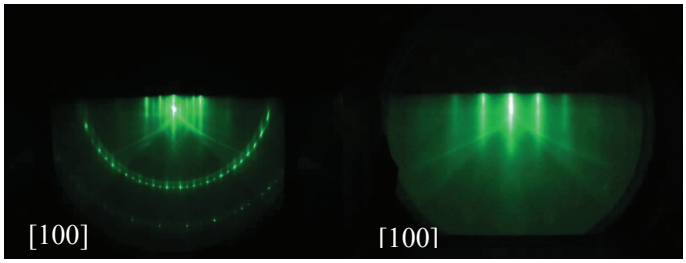

Fig.1 RHEED pattern of Fe_3O_4(001)

Fig.2 RHEED pattern of $CoCr_2O_4$(001)