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Fabrication of $CoFe_2O_4/LiTi_2O_4$ multilayers by molecular beam epitaxy

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【Introduction】

In recent electrical device industry, spintronics is a crucial technique which develops the memory technology from volatile to non-volatile. In the research field, high functional materials are required to realize novel spintronic devices. For example, Fe_3O_4 are predicted as a half metal, that have 100% of spin polarization, and $CoFe_2O_4$ is expected to be spin filter tunnel barrier. These oxides have spinel structure, so that spinel oxides are considered to be important materials. From the viewpoints of the epitaxial growth, the conductive spinel materials are suitable as the electrodes. However, Pt has been used as the electrode in the spinel spintoronic devices. If the materials with spinel structure are used as the electrodes, significant improvement in the magnetotransport properties is expected. $LiTi_2O_4$ are reported as an electrically conductive oxide with a spinel structure. Recently, Chopdekar et al. [1] and Kumatani et al. [2] succeeded in the fabrication of the epitaxial $LiTi_2O_4$ thin films by PLD method. In this study, we fabricated high-quality $LiTi_2O_4$ epitaxial films and $CoFe_2O_4/LiTi_2O_4$ multilayers by molecular beam epitaxy (MBE) and examined crystal orientation dependence of surface structures and transport properties.

【Experiment】

Films were fabricated by an MBE system. The sample structures were $Al_2O_3(0001)/LiTi_2O_4$. $LiTi_2O_4$ thin films were formed by reactive deposition at various T_{sub} in an O_2 atmosphere, and then were annealed for 30 minutes in vacuum. $CoFe_2O_4$ were formed on $LiTi_2O_4$ thin films by reactive deposition at 300℃ and annealing 300℃ for 30 minutes in an O_2 atmosphere. Partial pressure of O_2 was 4.0×10^{-4} Pa. The epitaxial growth and the surface structure were observed by RHEED and AFM.

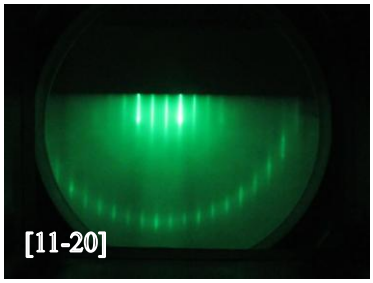

Fig.1　RHEED pattern of $LiTi_2O_4$ (50nm) grown at 300℃ and annealed at 700℃.

【Results】

Fig.1 shows the RHEED pattern of $LiTi_2O_4$ grown on $Al_2O_3(0001)$ at 300℃ and annealed at 700℃. The clear streak pattern was observed. From the AFM measurements, the surface roughness R_a was estimated at 0.76 nm. These results indicated that $LiTi_2O_4$ was flat epitaxial film. This $LiTi_2O_4$ film shows good conductivity ($\rho = 5.7\times10^{-4}\,\Omega$ cm) at room temperature and superconducting transition (Tc = 11K).

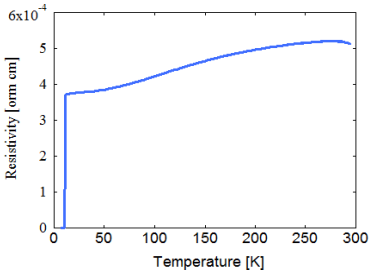

Fig.2　Temperature dependence of resistivity of $LiTi_2O_4$ (50nm).

【Reference】

[1] R.V. Chopdekar et al, Physica C 469 1885-1891 (2009)

[2] A. Kumatani et al, Appl. Phys. Lett. 101, 123103 (2012)