EC09

Inhomogeneous Surface Electronic Properties and Charge Ordering in Epitaxial Fe_3O_4 Films on MgO(001)

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Fabrication of high quality magnetite (Fe_3O_4) films is of a great increased interest recently for technological applications. This is due to the advantage properties of the predicted half-metallic characteristic, the high conductivity and the high Curie temperature of 858 K. Although Fe_3O_4 films grown on MgO exhibit a good stoichiometry, the films are well known as consist of a large number of structural domains separated by antiphase domain boundaries (APBs). The formation of APBs is the result of the intrinsic growth properties[1,2]. The investigation of the effects of the APBs on surface structural, electronic and magnetic properties is important since these properties are critical factors in determining spin transport behavior in the device's interfaces. In this work, we report scanning tunneling microscopy (STM) measurement results providing evidence for the important role of the APBs in modifying the surface electronic properties and charge ordering.

The epitaxial $Fe_3O_4(001)$ films were prepared on a MgO(001) substrate by means of deposition of iron under the presence of oxygen[3]. A flat surface can be obtained by post annealing in oxygen environment. STM images revealed the B-plane termination with wavelike Fe rows inducing a $(\sqrt{2}\times\sqrt{2})R45$ surface reconstruction.Fe rows are oriented along the [110] direction with ~0.6 nm separation. A single atomic periodicity of ~0.3 nm within the Fe rows is well resolved. Numerically calculated dI/dV curves representing the electronic properties, i.e. local density of states (LDOS), of the $(\sqrt{2}\times\sqrt{2})R45$ reconstructed surfaceexhibited peaks at 1.45 eV and 2.0 eV. A current imaging tunneling spectroscopy (CITS) image taken at a bias close to 1.45 eV showed a modulation of high and lesser current intensities along and across the rows (Fig. 1(a)-(c)). This feature indicated the presence of ordered Fe dimers with different LDOS indicating different charge states. Interestingly, this kind of charge ordering pattern is interrupted by the presence of an APB (Fig. 1(d)). Clearly, instead of ordered Fe dimers, atomic rows are observed in the disordered domain providing evidence for the important role of the APB in charge ordering phenomenon at the surface.

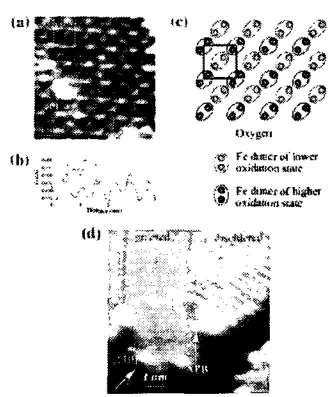

Fig. 1. CITS image and the corresponding line profile (b) and charge ordering model (c). (d) STM image showing ordered and disordered domains separated by an APB.

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EC10

Optical Properties at Localized Modes in First and Second Photonic Band Gaps of One Dimensional Magnetophotonic Crystals

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One dimensionalmagnetophotonic crystals (1D-MPCs), which consist of a magnetic Bi:YIG film as a defect layer and periodic dielectric films as Bragg mirrors, have feature of enhancement of magneto-optical effects at a localized mode in photonic band gaps (PBGs). So far, we had investigated linear and nonlinear magneto-optical properties of the 1D-MPCs [1], *however, optical properties of higher order PBGs and angle-dependencies were not elucidated yet.* In this study, we investigated magneto-optical effects at the localized mode in the second PBG, and incident light angle dependencies for p- and s-polarized lights in the first PGB. Understanding these optical properties would give us new scientific and technological aspects for the 1D-MPC.

The 1D-MPCs fabricated by RF sputtering method have the structure of $(Ta_2O_5/SiO_2)^5$/Bi:YIG/$(SiO_2/Ta_2O_5)^5$. Optical lengths of Bi:YIG was $\lambda_0/2$, ones of Ta_2O_5 and SiO_2 were $\lambda_0/4$ for utilizing the first PBG and $3\lambda_0/4$ for utilizing the second PBG, where λ_0 is wavelength at the localized mode.

Fig. 1 shows transmittance and Faraday rotation spectra of the 1D-MPC having the second PBG around 850 nm. At the localized mode at 873 nm, Faraday rotation of -0.9 deg. was obtained. Furthermore, Faraday rotation of -5.5 deg. was obtained at the localized mode in the third PBG vicinity of 527 nm. These are larger than Faraday rotation for a single Bi:YIG film. However, these Faraday rotation was not so large as expected results of the 1D-MPC having the first PBG. As the results of measurements of angle-dependencies for the 1D-MPC having the first PBG at 880 nm, different properties of transmittance and Faraday rotation were obtained in p- and s-polarized lights. That is, in case of p-polarized light, transmittance increased with increasing the incident light angle, but the Faraday rotation decreased. On the contrary, in s-polarized light, transmittance decreased with increasing the angle, and little decreasing of Faraday rotation was observed.

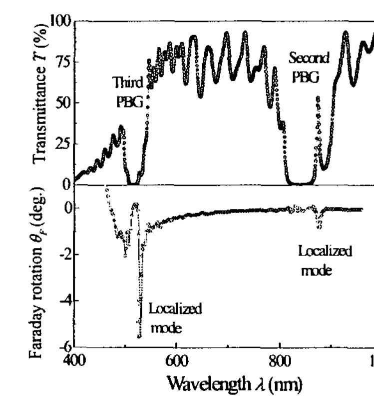

Fig.1. Transmittance and Faraday rotation spectra of the 1D-MPC having the second PBG around 850 nm

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