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GaMnAs の反射 MCD 測定における多重反射の効果

Multiple reflection effect in the reflection MCD measurement of GaMnAs

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Magnetic circular dichroism (MCD) measurement is a powerful method to characterize the ferromagnetism and band structure of ferromagnetic semiconductors. Indeed, the band structure of GaMnAs has been discussed from the results of MCD measurements [1] [2]. Especially, the reflection MCD measurement is often used because of easier sample preparation. However, reflection MCD spectra may be affected by the multiple reflection effect, which must be eliminated. In this study, we measured reflection MCD spectra of GaMnAs thin films with different thicknesses, and compared with calculated MCD spectra using the dielectric tensor and taking into account the multiple reflection effect.

Schematic sample structure is shown in the inset of Fig. 1 (a). $\text{Ga}_{0.98}\text{Mn}_{0.02}\text{As}$ ($d = 100$ nm)/ GaAs structure was grown on a semi-insulating GaAs (001) substrate by low temperature molecular beam epitaxy. Samples with $d = 50$ nm, 20 nm were fabricated by wet etching and they were characterized by MCD. The Curie temperature (T_C) of the GaMnAs samples was estimated by the Arrott plot using the MCD intensity vs. magnetic field characteristics. T_C was 27 K and did not change with d . The main graph of Fig. 1 (a) shows the MCD spectra of GaMnAs with $d = 100$ nm, 50 nm, and 20 nm, measured at 5 K at a magnetic field of 1 T applied perpendicular to the film plane. The MCD spectra of GaMnAs changed strongly with decreasing d . Fig. 1 (b) shows the calculated MCD spectra of GaMnAs, taking into account the multiple reflection effect. Here, we assumed that the diagonal elements of the dielectric tensor of GaMnAs are same as that of GaAs, multiple reflection was suppressed in the sample with $d = 20$ nm, and we estimated the off-diagonal elements of the dielectric tensor of GaMnAs from the MCD spectrum of the sample with $d = 20$ nm. Then, we calculated the MCD from the dielectric tensor, taking into account the multiple reflection effect. We succeeded in reproducing the MCD spectra of GaMnAs with $d = 50$ nm, 100 nm qualitatively. In the presentation, we will also discuss the results of the samples of Be-doped GaMnAs. The present results imply that rigorous conditions are required to obtain intrinsic spectra in reflection MCD measurements.

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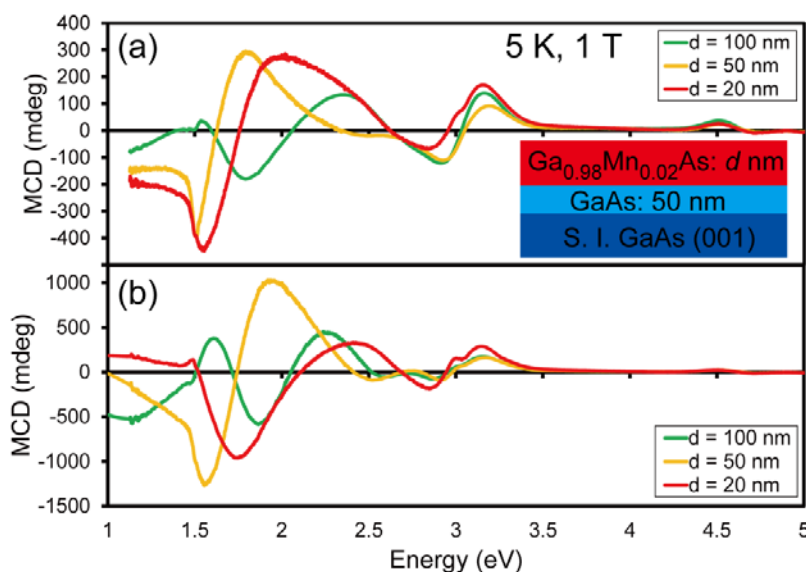


Fig. 1 (a) MCD spectra of GaMnAs with $d = 100$ nm, 50 nm, 20 nm, measured at 5 K at a magnetic field of 1 T applied perpendicular to the film plane. Inset: Schematic structure of the sample. (b) Calculated MCD spectra of GaMnAs, taking into account the multiple reflection effect.