Room-temperature ferromagnetism in (Zn,Cr)Te

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Ferromagnetic diluted magnetic semiconductors (DMSs) are the key material to developing semiconductor spintronic devices. One of the most characteristics physical phenomena in DMS is a strong interaction between sp-carriers and localized d-spins (sp-d exchange interaction) [1]. Confirmation of this interaction is essential to prove a synthesis of real DMS, and can be done directly by the magneto-optical studies such as a magnetic circular dichroism (MCD) measurement [2]. Here, we report room-temperature (RT) ferromagnetism with the sp-d exchange interaction in Zn$_{1-x}$Cr$_x$Te (x=0.20) [3]. Zn$_{1-x}$Cr$_x$Te films with x≤0.20 were grown on GaAs (001) substrates by a molecular beam epitaxy method. No sign of a secondary phase was detected in any films by the reflection high-energy electron and X-ray diffractions. MCD spectra were measured in a transmission mode. Magnetization (M) measurements were carried out using a SQUID. The $M-H$ curves of Zn$_{1-x}$Cr$_x$Te (x=0.20) showed a ferromagnetic behavior up to about RT. Curie temperature $T_C$ was estimated to be 300±10 K by the Arrott plot analysis. A strong enhancement of the MCD signal at the optical transition energies of critical points of host ZnTe was observed in Zn$_{1-x}$Cr$_x$Te, indicating a strong sp-d exchange interaction. The MCD spectra of Zn$_{1-x}$Cr$_x$Te at any magnetic field could be superposed upon a single spectrum, indicating that the observed MCD signals come from a single material, that is, Zn$_{1-x}$Cr$_x$Te. The magnetic field dependence of MCD intensity showed the ferromagnetic feature, which coincides with the $M-H$ curves measured using a SQUID. Furthermore, the MCD data showed the same $T_C$ as that obtained from magnetization data. These results indicate that Zn$_{1-x}$Cr$_x$Te (x=0.20) is an intrinsic DMS with RT ferromagnetism. References [1] J. K. Furdyna, J. Appl. Phys. 64, R29 (1988). [2] K. Ando, in Magneto-Optics, Springer Series in Solid-State Science, edited by S. Sugano and N. Kojima (Springer, Berlin, 2000), Vol.128, p. 211. [3] H. Saito, V. Zayets, S. Yamagata, and K. Ando, Phys. Rev. Lett., 90 207202 (2003).