INVESTIGATION OF THE ROLE OF COMPENSATION AND ORIGIN OF FERROMAGNETISM IN $GA_{1-X}MN_XAS$ USING MAGNETIC CIRCULAR DICHROISM STUDIES

Abstract

by

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III-Mn-V dilute magnetic semiconductors have emerged as promising candidate materials for future spintronic devices that could use the spin property of the carriers (in addition to their electrical charge) to manipulate information. During the past decade the most extensively studied semiconductor in this family is $Ga_{1-x}Mn_xAs$. It is widely accepted that the long-range ferromagnetic ordering of Mn moments in this material is induced by holes contributed by the Mn ions. These acceptors can either be neutral or in the form of compensated negatively charged centers. The precise role which these two centers play in determining the magnetic properties of GaMnAs is still not fully understood. Moreover, the role of Mn acceptors in determining the Zeeman splitting of band edges of GaMnAs needs to be investigated in depth. Magnetic circular dichroism (MCD) is a

powerful tool for investigating magneto-optical properties in thin magnetic layers, and in this study we apply this method to address the problem of Mn acceptor compensation in GaMnAs and its implication in determining the Zeeman splitting of band edges of GaMnAs, with the aim of shedding additional light on the co-relation of hole concentration and Curie temperature of these samples with Zeeman splitting of band edges.

The focus of this thesis is the analysis of magnetic circular dichroism data taken on thin GaMnAs films with low Mn concentration. Our measurements revealed that exchange-induced spin splitting of the band edges occurs only in samples that show ferromagnetic order, and is not observed in paramagnetic samples. These results lead to the conclusion that Mn ions in the A^0 configuration (d^5 + *hole*) provide the only mechanism for exchange interaction between Mn spins and band carriers. We also show that there is a linear relation between the observed exchange-induced splitting of the band edges and the Curie temperature, pointing to a common origin of the band edge splitting and ferromagnetism in GaMnAs.