OPTICAL AND TRANSPORT STUDIES OF MAGNETIC SEMICONDUCTORS

Abstract

by

Shaoping Shen

In this thesis, various studies of magneto-transport and magneto-optical effects in III-V and II-V magnetic semiconductors are presented. The magneo-transport study involved the investigation of the anomalous Hall effect (AHE) in (Ga,Mn)As epilayers with low Mn concentration, grown in ultra-high vacuum molecular beam epitaxy (UHV MBE) chamber. Experiments were carried out in National High Magnetic Field Laboratory (NHMFL) on a series of samples with same Mn concentrations (x = 1.4%) but with various Be co-doping levels. We observed a sublinear relationship between the transverse resistivity ρxy and the longitudinal resistivity ρxx with a scaling factor n = 0.5, which has not been predicted theoretically.

We also investigated the magneto-optical and magnetic properties of two quaternary diluted magnetic semiconductor (DMS) alloys, Cd1-x-yMnxCryTe and Cd1-x-yMnxCoyTe grown by the vertical Bridgman method, with a fixed Mn

concentration $x \sim 0.37$ and, respectively, with concentrations of Cr in the range $0 < y < 0.07$ and Co in the range $0 < y < 0.009$. The introduction of Cr and Co leads to very different behaviors, including the occurrence of ferromagnetic order in the case of Cd1-*x*-*y*Mn*x*Cr*y*Te and several interesting optical transitions for Cd1-*x*-*y*Mn*x*Co*y*Te. We discuss the possible origins of these observed behaviors.

Last, we focused on DMS based nano-structures. Magnetic circular dichroism (MCD) studies have been carried out on a series of 1.4 nm thick CdSe:Mn nano-ribbons synthesized via colloidal chemical route. MCD spectra have been used for investigating the Zeeman splitting in these one-dimensional (1D) quantum confined diluted magnetic semiconductor nanostructures. In all samples, a strong MCD signal was found at about 2.9 eV due to a large Zeeman splitting of the exciton confined in the nano-ribbon. The Zeeman splitting is a result of strong *sp-d* exchange interaction between the electronic holes of the nano-ribbons and localized magnetic moment of Mn2+ ions. Our results suggest that the sign of the *s-d* exchange parameter α in these nanoribbons is inverted with respect to CdMnSe bulk value due to the admixture of the valence band wave functions to the conduction band ones.