OPTICAL STUDIES OF LOW DIMENSIONAL MAGNETIC AND NON-MAGNETIC SEMICONDUCTOR STRUCTURES

Abstract

by

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The focus of this thesis is on optical studies of the properties of semiconductor heterostructures fabricated by the molecular beam epitaxy.

ZnCdSe quantum wells were grown on the cleaved (110) edge of ZnCdSe/ZnSe multiple quantum well structures with the intent of creating T-shaped quantum wires at intersections of the quantum wells. Extensive polarization-dependent micro-photoluminescence studies were carried out on all the samples. We report the observation of the photoluminescence emission from the quantum wire in one of the samples. The absence of the quantum wire photoluminescence lines in other samples may be caused by the roughness of the interfaces formed by ZnCdSe deposition on the cleaved (110) surface which can affect the quality of the T-junctions formed by the intersection of the quantum wells. In addition to preliminary success in fabricating ZnCdSe quantum wires in the ZnSe matrix, this work has also resulted in the observation of zero-dimensional ZnSe/ZnCdSe quantum structures (natural quantum dots). The natural quantum dots result from the carrier localization on the fluctuations of the thickness of the ZnCdSe quantum wells grown on (110) cleaved surface due to (110) interface roughness.

We also describe the properties of self-assembled CdSe quantum dots grown on

Mn-passivated ZnSe buffers. We show that the Mn deposited on the ZnSe surface acts as a nucleating seed for self-assembled QD formation. At certain optimal growth conditions, the presence of Mn on ZnSe surface results in a significant improvement in size uniformity compared to CdSe dots grown on ZnSe without Mn passivation as evidenced by photoluminescence as well as transmission electron microscopy experiments. We also show that the dots exhibit large Zeeman splitting observed in the photoluminescence emission, indicating that this growth method is suitable for fabricating magnetic quantum dots that exhibit strong spin polarization effects.

In addition to our studies of the II-VI semiconductor heterostructures, we have investigated the magnetic properties of ferromagnetic GaMnAs, GaMnSb, and InMnSb grown on hybrid GaAs/II-VI substrates by the magneto-optical Kerr effect and magnetic circular dichroism measurements. The results of the magneto-optical experiments were compared with those obtained by direct magnetization measurements and electrical transport.