Nanoscale physics

Optical spectroscopy of semimagnetic CdMgTe/CdMnTe heterostructures

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The uncoupled quantum wells (QWs) Cd1-yMgyTe/Cd1-xMnxTe/Cd1-yMgyTe of diluted magnetic semiconductors grown by molecular beam epitaxy on the semi-insulating substrate GaAs (100) allow to realize spin QWs, where confined potential is manipulated by applied magnetic field. In such structures equal offset for valence bands (Q_V = 0.30) of Cd1-xMnxTe and Cd1-yMgyTe is hold up to high concentrations (~ 27%) both of Mn and Mg making these structures ideal for study of spin superlattices. By means of optical and magneto-optical investigations we have measured concentration dependences $\Delta E_0^{QW}(x)=E_0^{QW}(x)-E_0^{QW}$ of difference between the resonant energy of two-dimensional excitons $E_0^{QW}(x)$ localized in the $Cd_{0.8}Mg_{0.2}Te/Cd_{1-x}Mn_xTe/Cd_{0.8}Mg_{0.2}Te$ QW with $0 \le x \le 0.05$, and the energy of free excitons E_0^{QW} in the CdTe crystal. These dependences are found to be substantially dependent on the QW thickness and become strongly nonlinear for the case of thin QW. Nevertheless the calculations carried out in approximation of virtual crystal for the energy gap give linear dependence on the manganese concentration. We assume that the measured nonlinearity is a consequence of local deformations and disordering of QW, influenced by small concentration of Mn. The presence of manganese treats the structural defects and effectively changes the thickness of QW. Our finding of the bowing of the concentration dependence of Eg on Mn under thinning the QW can be of importance for band gap engineering of quantum well heterostructures exploited in spintronics.