Anomalous behavior of the indirect excitons in (Cd,Mn)Te/(Cd,Mg)Te/CdTe double QW structures

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Interest in the study of double quantum well (DQW) semiconductor nanostructures is often related to the attempt to create a condensed state of so-called indirect excitons, which have a long exciton lifetime due to the localization of the exciton electron and hole in different QWs. This communication reports a new phenomenon in the photoluminescence (PL) of DQWs constructed from CdTe and CdMnTe QWs separated by a CdMgTe barrier. It has been found that the energy of indirect excitons (IX) in DQWs in the samples studied depends significantly on the energy of the excitation photon. To the best of our knowledge, such an effect has not been discussed previously.

Here we present the results of a study of exciton systems of CdMnTe/CdTe DQW structures consisting of a bound 15 nm width DMS QW, a non-magnetic CdTe QW with width varied in the range 6-10 nm, separated by a 2 nm width CdMgTe barrier. The stationary and time-resolved spectra of PL and PL excitation (PLE) were studied over a wide range of magnetic fields and optical excitation energies and intensities. Fig.1 shows magnetic field dependencies excitons energies at different powers of excitation (a), PL spectra of excitons from DQWs at different excitation energies in the magnetic field (b) and the emission energy dependence of indirect exciton (IX) and trion (T) from CdTe QWs on the excitation photon.

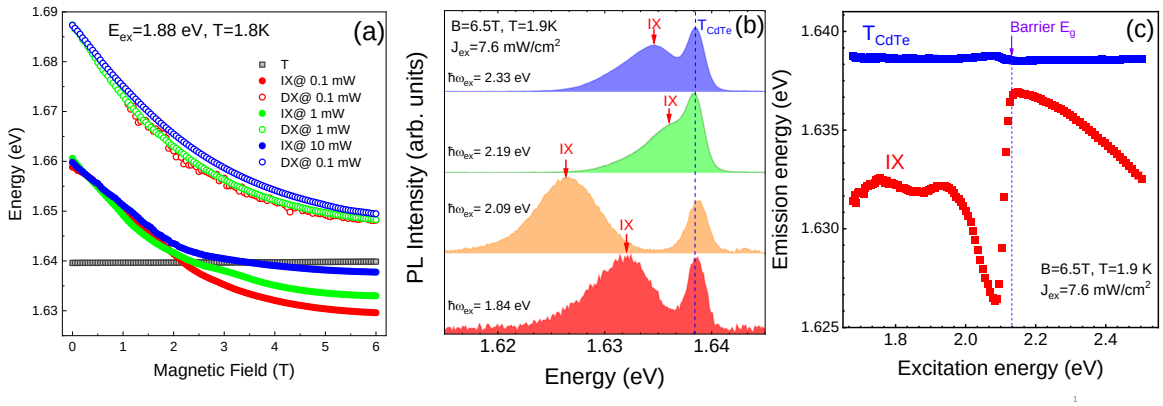

Fig.1 (a) Dependence of the energies of IX, DX from DMS QW and T energies on the magnetic field at different excitation powers; (b) PL spectra at different excitation powers at B=6.5 T; (c) Dependence of the energies of IX and T on the excitation power. The values of temperature, magnetic field and excitation power density are shown in the inset.

Anomalous non-monotonic behavior of the IX emission spectrum is observed near the energy of a (Cd,Mg)Te barrier band edge, while direct exciton from DMS WQ (DX) and trions (T) do not depend on the optical excitation energy. The energy difference between IX and T, i.e. the magnitude of the effect, is generally dependent on the optical excitation power density, but at low excitation power densities, this dependence disappears. We propose that the main mechanism responsible for this effect is due to the accumulation of photo-induced carriers in different QWs, which induces the appearance of an intrinsic electrostatic field that strongly modifies the energy spectrum of IX.