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ADP012867

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7th Int. Symp. "Nanostructures: Physics and Technology"
St Petersburg, Russia, June 14–18, 1999

Cladding layer effect on the reflectance and transmission spectra in the CdTe/CdZnTe MQWs

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Recently it was shown that the oscillator strength of an exciton resonance in a MQW system depends not only on a QW width, but on a period of MQW structure as well [1]. The exciton-photon coupling has been found to enhance in a MQW structure with a period equal to one half and is weakened in a structure with a period equal to one fourth of a light wavelength in a barrier material. Thus, the coupling effect between photon modes and an exciton in a QW depends crucially on the optical path of the incident light.

In the present paper the cladding layer effect on the reflectance and transmission spectra in the CdTe/CdZnTe MQWs has been studied. It is known from the literature [2] that the reflectance lineshape in the exciton resonance region is emission-like when the wave, reflected from the surface and the one, reflected from the QW are in the same phase, i.e. when the distance between the QW and the surface is equal to $n\lambda/2$, where n is an integer (Bragg conditions). However, the reflectance lineshape shows an absorption-like nature when this distance is equal to $(2n+1)\lambda/4$, i.e. both waves have opposite phases (anti-Bragg conditions).

We studied the reflectance and transmission spectra of the CdTe/$Cd_xZn_{1-x}Te$ ($x = 0.13$) MQW structures. The experiments were carried out at the temperatures of 1.6 K and 77 K. The structures studied consist of the two QWs of the different widths ($L_z = 58$ Å and $L_z = 74$ Å) sandwiched by the $3\lambda/4$-thick cladding layer, $\lambda/4$-thick barrier (where λ is light wavelength in the barrier material), and the CdTe/$Cd_yZn_{1-y}Te$ substrate ($y = 0.12$).

The main point of the investigation was to study the modification of the reflectance spectra and to find out the dependence of the exciton resonance parameters (radiation damping and oscillator strength) on the optical path of the light. By tuning the incidence angle we varied the optical path and, consequently, tuned the phase difference, which resulted in a modification of the reflectance lineshape. The existence of two QWs of the different widths placed on the different distances from the surface allowed us to monitor the modification of the reflectance lineshape at different incident angles. In the transmission experiment it was shown that at the Bragg conditions the exciton resonance line is more distinct than that at the anti-Bragg conditions.

The reflectance and transmission spectra of the two structures, each containing two QWs, are shown in the Fig. 1(a) and (b). In the structure presented in the Fig. 1(a) the 74 Å QW is placed on the distance of $3\lambda/4$ from the surface and the 58 Å QW is on the distance of λ from the surface. In the Fig. 1(b) the positions of the QWs are inverted.

From the comparison of Fig. 1(a) and (b) one can see that for the QW placed on the $3\lambda/4$ distance from the surface the amplitude of an exciton resonance lineshape, and consequently its oscillator strength is sufficiently (about 1.5 times) greater than that of the QW placed on

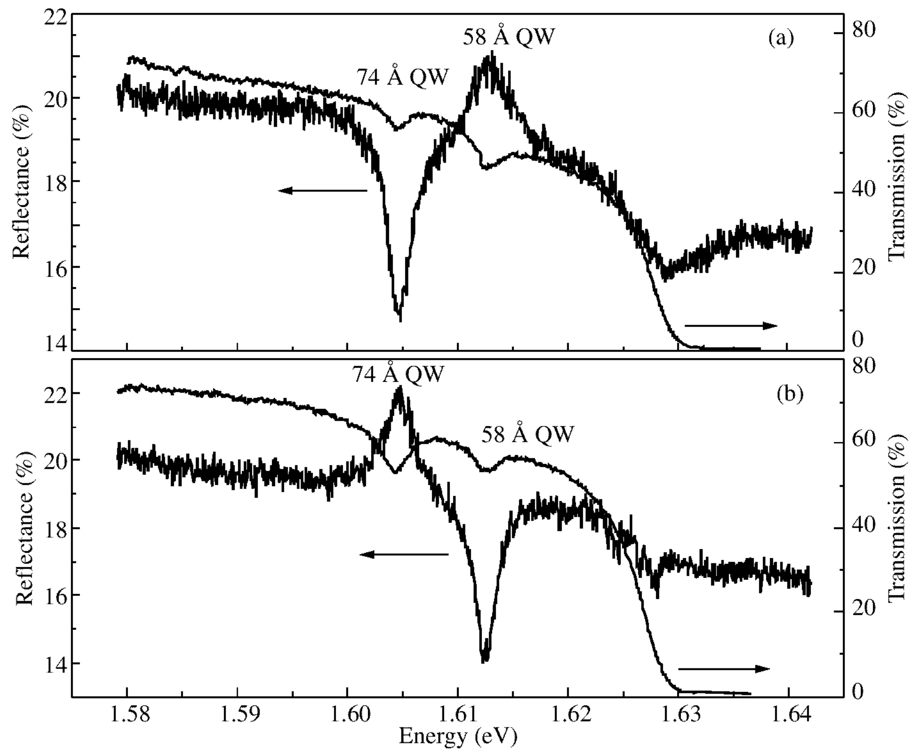

Fig. 1. Reflection and transmission spectra measured at 77 K at normal light incidence. (a) in this sample the 74 Å-thick QW is placed on the $3\lambda/4$ distance from the surface and the 58 Å-thick QW is placed on a λ distance from the surface. (b) in this sample the 58 Å-thick QW is placed on the $3\lambda/4$ distance from the surface and the 74 Å-thick QW is placed on a λ distance from the surface.

the λ distance from the surface, and this effect is defined completely by the surface-to-QW distance of the sample.

Thus, the oscillator strength of an exciton in a single QW is defined not only by the overlap of the electron and hole wavefunctions as was believed recently, but is defined by the electromagnetic field distribution in a structure as well.

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