Impact of carriers on the Optically Detected Magnetic Resonance measured for (Cd,Mn)Te based quantum wells

A.Łopion, A.Bogucki, K.E.Połczyńska, W.Pacuski, T.Kazimierczuk, A.Golnik and P.Kossacki

Faculty of Physics, Institute of Experimental Physics, University of Warsaw, ul. Pasteura 5, 02 093 Warszawa, Poland
Piotr.Kossacki@fuw.edu.pl

In this work, we combine magnetooptical measurements and optically detected magnetic resonance (ODMR) technique to study magnetic system composed of Mn^{2+} ions in (Cd,Mg)Te/(Cd, Mn)Te QWs with charge carriers.

The advantage of the ODMR technique is the possibility to study local properties of magnetic ions incorporated in well-defined position of nanostructure. The basic information extracted from the ODMR spectra is the energy level structure of the Mn^{2+} ion, which depends, e.g., on the local strain [1]. Although the ODMR technique in diluted magnetic semiconductors is sensitive selectively to the magnetic ions, the detailed analysis of the measured signal reveals interactions within the magnetic ion system or between ions and charge carriers [2] and the temperatures of the subsystems.

The nominally undoped (Cd,Mn)Te/(Cd,Mg)Te quantum wells are typically p-type [3]. The hole gas originates from the background doping of the (Cd,Mg)Te barrier material or the surface states. By covering the (Cd,Mn)Te/(Cd,Mg)Te QW structure with a nickel metallic layer, we produced a sample with different carrier gas properties. As we observe by magnetooptical measurements, the hole gas is replaced by electron gas in the QW. Depending on the conditions, we have observed that the ODMR signal is affected by the carriers present in the sample in two ways. The first effect is the shift between the ODMR signals obtained on neutral and charged exciton (Knight shift). The second one is a change in the spin-lattice relaxation (SLR) rate in the presence of the carriers.

At the same time, the shape of the ODMR signal keeps the information about the temperature of the magnetic ions involved in the absorption of the MW. Studying it in detail can provide even more information about interactions with charge carriers.

[1] A. Bogucki, et al., *Phys. Rev.B* **105**, 075412 (2022).
[2] A. Łopion, et al., *Phys. Rev.B* **106**, 165309 (2022).
[3] W. Maślana, et al., *Appl. Phys. Lett* **82**, 1875 (1875).