Optically Detected Magnetic Resonance in (Cd,Mn)Te-based quantum wells with the carrier gas

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

The advantage of the ODMR technique is the possibility of studying the local properties of magnetic ions incorporated in well-defined positions of the 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].

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 in the QW is replaced by electron gas. 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).