Magnetic field and temperature dependence of the Mn^{2+} spin relaxation rate in a (Cd, Mn)Te/(Cd, Mg)Te quantum well

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

Institute of Experimental Physics, Faculty of Physics, University of Warsaw, ul. Pasteura 5, 02-093, Warszawa, Poland

The spin-lattice relaxation rate is an important parameter that determines whether a magnetic ion can be considered for information processing applications. More precisely, the dependence of the relaxation rate on parameters such as temperature and magnetic field can provide clues as to what type of mechanism is responsible for the energy dissipation.

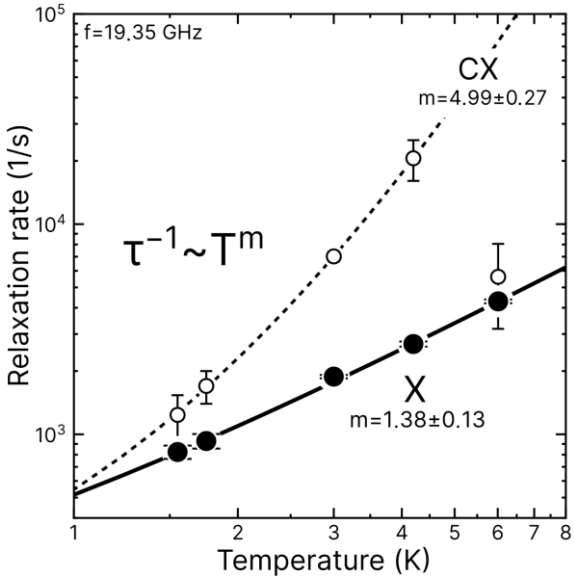

Figure 1 The spin-lattice relaxation rate of the Mn^{2+} ions in CdTe quantum well vs temperature can be described with the power function. The relaxation rate dependence of the neutral exciton (X) is dominated by the direct mechanism. In contrast, the charged exciton (CX) dependency suggests multi-phonon processes.

In this work we present the results of the spin-lattice relaxation rate measurements of a (Cd, Mn)Te/(Cd, Mg)Te quantum well. For this purpose we utilize the time-resolved optically detected magnetic resonance (ODMR) technique known for its sensitivity [1]. The spin-lattice relaxation time of Mn^{2+} ions in the (Cd, Mn)Te/(Cd,Mg)Te quantum well was measured as a function of magnetic field and temperature (see Fig. 1).

Obtained results can be explained in the frame of a modified model described in [2]. The modified model takes into account that energy levels of manganese are not equally spaced. The distance between the Mn^{2+} energy levels depends on the magnetic field and strain present in the sample. The observed temperature and magnetic field dependencies are well described by proposed model. Our results suggest that the dominant mechanism of energy dissipation in the measured system is the so-called 'direct process', in which a phonon is emitted or absorbed.

[1] A. Łopion, A. Bogucki, W. Kraśnicki, K. E. Połczyńska, W. Pacuski, T. Kazimierczuk, A. Golnik, and P. Kossacki, *Magnetic Ion Relaxation Time Distribution within a Quantum Well*, Phys. Rev. B 106, 165309 (2022)

[2] A. M. Witowski, *Numerical Studies of Magnetization Relaxation of Mn $^{2+}$ in Zinc Blende Crystals*, Acta Phys. Pol. A **82**, 876 (1992).