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Spin dynamics in diluted-magnetic-semiconductor heterostructures with free carriers

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Magnetic, optical and transport properties of heterostructures based on diluted magnetic semiconductors (DMS), which are treated nowadays as model structures for spintronic devices, are determined by coupled systems of magnetic ions, lattice (the phonon system) and free carriers. The system of free carriers (its concentration, temperature and spin polarization) is of great importance for static characteristics and dynamical response of DMS materials as it modifies strongly efficiency of energy- and spin transfer between the systems of DMS heterostructures.

I will give an overview of our recent experiments on II-VI DMS heterostructures with free carriers created either by means of photogeneration or by modulation doping. Magneto-optical studies of ZnMnSe/ZnBeSe and CdMnTe/CdMgTe quantum wells with a type-I band alignment and type-II ZnMnSe/BeMnTe heterostructures will be reported. Structures with n-type and p-type modulation doping have been examined.

Phenomena related to the spin- and energy transfer between systems of magnetic ions, free carriers and lattice will be in the center of attention. Efficiency of coupling of these systems is examined by selective heating:

(i) of the magnetic ion system via photocarriers [1,2,3],
(ii) 2DEG by electrical current and
(iii) the lattice (i.e. phonon system) by injection of nonequilibrium phonons [4,5].

Strong enhancement (by two-three orders of magnitude) of the spin-lattice relaxation rate for magnetic ions is found in the presence of free carriers of moderate density about 10^{11} cm^{-2}.

This work results from the close collaboration with M.Kneip, M.Bayer, A.A.Maksimov, A.V.Scherbakov, A.V.Akimov, D.Keller, W.Ossau, L.W.Molenkamp, and A.Waag.

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