Individual CdSe/ZnSe quantum dots with a few Mn^{2+} ions.

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Quantum dots (QDs) with magnetic ions are a useful tool in studies of ion-lattice interactions. Many interesting phenomena involving such dots have been investigated, such as an optical spin control of a single magnetic ion [1-2]. However, most of these studies were limited to CdTe and InAs QDs doped with Mn^{2+} ions, due to a common belief that photoluminescence is severely quenched in systems for which the exciton energy is higher than the intra-ionic transition energy. While this is true for highly doped materials [3,4], it was recently shown that exciton emission quenching is negligible in the case of single dopants in QDs [5]. In this work we investigate in detail the properties of individual CdSe QDs doped with single and a few Mn^{2+} ions, in order to understand all aspects of the photoluminescence quenching mechanism.

Sample used in our experiments contains MBE-grown, self-assembled CdSe/ZnSe QDs with a various manganese content. Using polarization-resolved photoluminescence measurements under non-resonant continuous-wave excitation in magnetic field of up to 10 T we are able to identify dots without magnetic ions, dots with single Mn^{2+} dopant, as well as those with a few manganese ions. With the use of time-resolved spectroscopy under pulsed excitation we analyze in detail the dynamics of exciton recombination in such dots. Although we can observe a slight decrease of the exciton lifetime in QDs under investigation, we conclude that presence of even a few magnetic dopants does not introduce an efficient non-radiative exciton recombination channel. In view of those results we discuss the role of the magnetic ions present in the barrier material in the photoluminescence quenching process, as well as possible importance of electron or hole Mn-assisted spin-flip, leading to creation of dark excitons in the QD.

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