Optical properties of CdTe:Ni quantum dots

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According to development of quantum technologies such as spintronics, solotronics or quantum computing there is a need to understand better the spin properties of impurity interacting with the semiconductor lattice and confined carriers. Zero dimensional semiconductor structures such as epitaxial quantum dot (QD) are a model system to probe fundamental interactions in condensed matter. For example QDs can be used to examine spin of a single magnetic ion [1] or its charge fluctuation [2].

In this work we examine self-assembled CdTe:Ni QDs grown by molecular beam epitaxy, in ZnTe barrier. With increasing amount of deposited Ni, in photoluminescence study we observe reduction of QDs density by orders of magnitude (down to 1-3 QDs per 1 μm^2). In micro-photoluminescence study we observe three kinds of individual QDs: i) typical nonmagnetic QDs, ii) QDs, where each excitonic complex is split to several well resolved lines iii) QDs with broad lines and weak anisotropy.

One can expect that QDs with multiple lines could be related to QD individual ion [1,2,3,4], in our case Ni ion, however linear polarization analysis and magneto-optics studies show that these QDs behave rather like two similar dots emitting at slightly different energies. The probability to find two independent charged dots with similar μ-PL intensities, regular energy spacing and common excited states is very low, therefore such a behavior can be explained by interaction between charge fluctuations of a Ni atom located in a ZnTe barrier near examined QD [2].

Instead, QDs with broader lines exhibit weak magneto-optical properties which can be attributed to *s,p-d* exchange interaction between exciton and Ni ion. Such weak magneto optical effects can be explained by weak Van Vleck type magnetism of Ni^{2+} ion with integer spin (S=1).

[1] L. Besombes et al, *Phys. Rev. Lett.* **93**, 207403 (2004).
[2] L. Besombes et al, *Phys. Rev. B* **99**, 035309 (2019).
[3] J. Kobak et al, *Nat. Commun.* **5**, 3191 (2014).
[4] T. Smoleński et al, *Nat. Commun.* **7**, 10484 (2016).