Spin splitting anisotropy in CdMnTe quantum dots embedded in ZnTe nanowires

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In this report, we study photoluminescence (PL) of single, semimagnetic CdMnTe quantum dots (QDs) embedded into ZnTe nanowires (NWs). We show that the giant Zeeman splitting of the excitonic transitions exhibits a strong anisotropy depending on the direction of the applied magnetic field (B): the splitting in B oriented parallel to the wire axis being few times larger than for perpendicular field – see Fig.1. We interpret this as a result of pinning of the heavy hole (hh) spin to the quantization (i.e., growth) axis, which results in a vanishing hh splitting in perpendicular field. Therefore, the observed Zeeman splitting results solely from the splitting in the conduction band and any light hole (lh) admixture to the hh ground state. Assuming bulk exchange constants and comparing the splittings in parallel and perpendicular fields for a number of dots, allows us to evaluate these admixtures and find that the degree of hh-lh mixing varies from 0 to about 50%.

The samples are grown epitaxially by a vapour-liquid-solid method using gold droplets as catalysts. The NW diameters range from 80 nm to 150 nm and the length is up to 1.8 μm. The presence of CdMnTe insertions results in the appearance of a PL in 1.8 eV–2.2 eV energy range. We show that this broad band consists of individual lines coming from single QDs in NWs. An average linewidth is about 7 meV. This broadening of the PL transitions is due to magnetization fluctuations. The transitions exhibit a strong linear polarization of the PL, 84% on average. This polarization originates from the dielectric contrast between the NW and its surroundings. Thus, its measurement allows us to determine that the emission comes from the NW and assess its orientation. Monochromatic mapping of the cathodoluminescence correlates with the scanning electron micrograph, which confirms that the observed emission originates from QDs in NWs and not from any other structures. PL measurements are performed at temperature of 2 K in a cryostat equipped with a double-coil magnet producing magnetic fields at arbitrary angle. In order to apply B parallel and perpendicular to the wire axis, we determine the orientation of the wire by measuring PL linear polarization anisotropy.

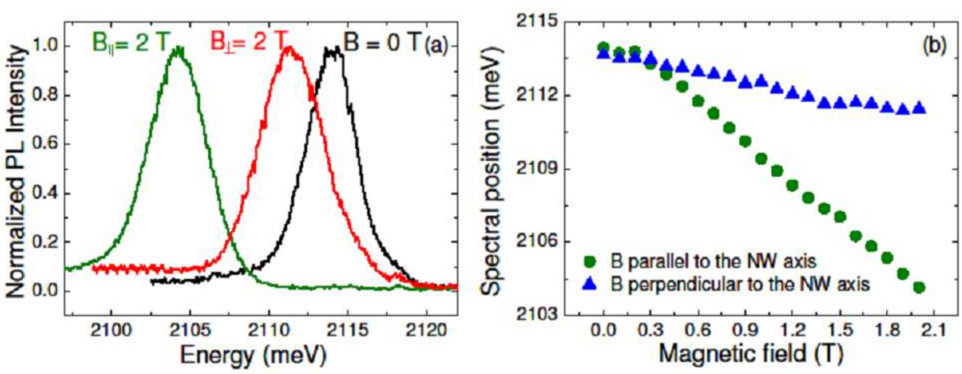

Figure 1. (a) Normalized PL spectra for a single QD in a NW for magnetic fields 0T and 2T, applied perpendicular and parallel to the NW axis. (b) Transitions energies as a function of magnetic field for two measurement configurations.