Enhancement of CdTe quantum dots photoluminescence in the yellow range

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Microcavities embedding quantum dots are of great interest from the point of view of fundamental physics (quantum electrodynamics, light-matter coupling) and applications in the active field of optoelectronics. Intense investigations on such structures carried out in many laboratories lead to the realization of, among others, vertical cavity surface emitting lasers (VCSELs) and resonant cavity light emitting diodes (RCLEDs). Pillar microcavities, etched by focused ion beam (FIB), and containing a single QD allow controlling spatial, energetic and temporal properties of light emission [1, 2]. In such structures, the coherent coupling between light and matter is of great interest for quantum information processing. Since II-VI semiconductors exhibit stronger carrier confinement and more robust excitonic states than in III-V materials, II-VI based microcavities are expected to extend the functionalization of the devices and the fundamental investigations on light matter coupling to higher temperatures [3]. In addition, II-VI compounds based emitters are good candidates to answer the problem of the low efficiency of III-V based emitters in the green yellow range [4]. In particular, the realization of yellow range (560 – 595 nm) optoelectronics devices could have important applications in medicine, data transmission, or optical spectroscopy.

In this work we report on the influence of distributed Bragg reflectors based on lattice matched ZnTe and the digital alloy ZnTe|MgTe|ZnTe|MgSe layers [5] on the photoluminescence of self-organized CdTe/ZnTe quantum dots grown by molecular beam epitaxy (MBE), emitting in the yellow range. We show that in the case of quantum dots grown on a Bragg reflector, the photoluminescence intensity is enhanced by more than one order of magnitude compared to quantum dots grown on a ZnTe buffer, whereas the single quantum dots lines are wider. The recovery of sharp single emission lines is obtained by growing a thicker ZnTe layer in the cavity under the quantum dots sheet. Indeed, high resolution transmission electron microscopy (HRTEM) analysis allows to identify a thin ZnSe layer, which deposition results from the growth process, under the quantum dots sheet and disturbs their formation. The final microcavity structure exhibits both an intense photoluminescence peak from the ensemble and sharp emission lines from single quantum dots. This should lead to the achievement of a yellow range laser, as stated in previous publication [6], and the possibility to study the coupling of light with a single QD in a pillar microcavity. In the case of a QD with a single magnetic ion, such a structure would be of particular interest for the emerging and promising field of solotronics [7].

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