Tailoring the polarization anisotropy of a single InAs quantum dash by a post-growth modification of its dielectric environment

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Linearly polarized single photon emitter as a source of deterministic qubits can alter for the better the efficiency of coding information using BB84 quantum cryptography protocol [1]. We present our recent research on single InAs/InGaAlAs/InP quantum dashes in this context using high-resolution microphotoluminescence experiment that reveals the excitonic emission with a significant fine structure splitting that lifts the degeneracy of electron-hole spin states which results in two linearly polarized components. Our approach to control a degree of linear polarization (DOP) is based on a modification of sub-micrometer etched mesa structure of different geometry from squared to rectangular shape (aspect ratio 2:1). We performed polarization resolved experiment which shows a profound influence on intensity of cross-polarized exciton spectral lines for two differently oriented rectangles with respect to the elongation axis of quantum dashes along [1-10] direction showing the ability to tune the DOP from -10 % up to 60% (Fig.1). Such characteristic is fulfilled in all available spectral range from 1.3 to 1.6 μm provided by the control of nanostructure cross-section during the MBE growth process.

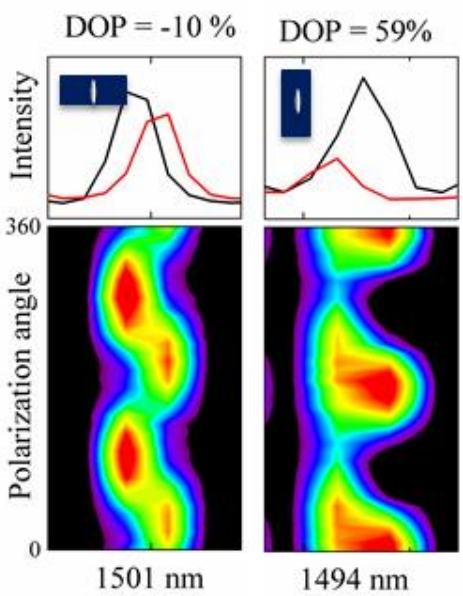

Fig.1. Linearly polarized microphotoluminescence spectra of exciton for a different mesa orientation

We propose a theoretical model based on coupling of the fundamental modes of electromagnetic field confined in the mesa structures to the QDash emitter with intrinsic DOP of ~25% driven mainly by the valence-band mixing [2]. The results of calculations reproduce well the experimental data of DOP for rectangular shaped mesa, decreasing the mesa effect with its size increase and no significant effects related to the change of exciton's emission wavelength.

[1] A. Lundskog, C.-W. Hsu, K. Fredrik Karlsson, S. Amloy, D. Nilsson, U. Forsberg, P. Olof Holtz, and E. Janzén, *Light Sci. Appl.*, **3**, 139 (2014)
[2] A. Musiał, P. Kaczmarkiewicz, G. Sęk, P. Podemski, P. Machnikowski, J. Misiewicz, S. Hein, S. Höfling, and A. Forchel, *Phys. Rev. B*, **85**, 035314 (2012)