InAsP/InP quantum dot nanowires: from the new potential to the growth challenges

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The exploitation of quantum dots (QDs) embedded into nanowires (NWs) has some advantages compared to other types of QDs. Most importantly, the NW geometry allows to combine also highly lattice-mismatched materials in defect-free heterostructures due to the strain relaxation along the NW sidewalls. Moreover, the vapor-liquid-solid (VLS) NW growth mechanism leads to the possibility to control and tune QD features like dimensions, crystal phase, composition, density, and positioning along the NW axis [1]. Among the heterostructures explored in literature for telecom emission, $InAs_xP_{1-x}$ QDs in InP NWs have been investigated. Commonly, these QDs are grown along the <111>B direction. However, in this growth direction polytypism and stacking faults typically occur, strongly affecting the optical quality. Conversely, NWs grown along the <100> direction show a pure zincblende (ZB) crystal phase for a wide range of diameters and growth conditions [2].

In this contribution, I will present our results on the growth of ZB $InAs_xP_{1-x}$ QDs in InP NWs, achieved by Au-assisted VLS growth in a Chemical Beam Epitaxy system. We studied the growth of InP/$InAs_xP_{1-x}$ heterostructures with different compositions to control the straight growth along the <100> direction and to tune the emission wavelength. Interestingly, we found that the growth mechanism of pure InAs QDs differs from $InAs_xP_{1-x}$ alloy QDs. This allowed us to optimize different growth protocols to achieve straight growth of the final QD NWs. We successfully obtain the growth of $InAs_xP_{1-x}$ QDs with a composition in a range of x = 0.24 – 1.00. By means of micro-photoluminescence (μ-PL) measurements, we demonstrate the tunability of the emission, as a function of the $InAs_xP_{1-x}$ QD composition and morphology, remarkably observing an emission at the telecom O-band for a 10 nm thick QD with 80% of As content [3].

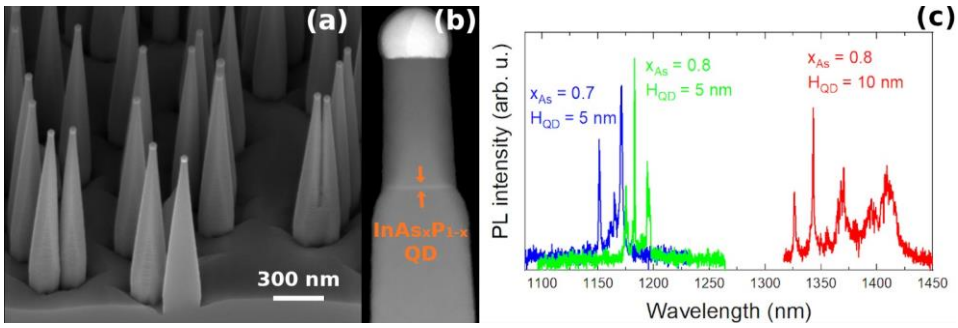

Figure1. (a) tilted SEM image of InAsP/InP QD NWs. (b) STEM image of a representative QD NW. (c) μ-PL spectra of single QD NWs of various thicknesses (H) and composition (x).

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