**MBE growth and study of low-density InAs/GaAs quantum dots and wetting layer** G. Trevisi[a], L. Seravalli[a], P. Frigeri[a], C. Bocchi[a], V. Grillo[a], L. Nasi[a], I. Suárez[b], D. Rivas[b], G. Muñoz-Matutano[b] and J. Martínez-Pastor[b]
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Semiconductor quantum dots (QDs) prepared with Molecular Beam Epitaxy (MBE) represent an interesting approach to the development of single-photon sources at telecom wavelengths [1]. Structures with low QD density can be successfully prepared by using growth conditions that lead to increased cation migration length, such as relatively high QD growth temperature and/or low QD growth rate [2]; long-wavelength emission, on the other hand, may be obtained by inserting an InGaAs upper confining layer (UCL) on top of the QDs [3]. A complete picture of the properties not only of QDs but also of the wetting layer (WL) in these structures is particularly interesting since WL states have important effects on QD carriers dynamics.
We present here the study of morphological, structural and optical properties of MBE-grown structures in which QDs were deposited at low growth rate (0.01 ML/s) and high growth temperature (520 °C) and capped with InGaAs UCLs [4]. Owing to these particular design and growth parameters, the structures have QD densities of 4-5x$10^9$ $cm^{-2}$ and emission wavelengths ranging from 1.20 to 1.33 µm at 10 K. The WL properties were investigated with low temperature photoluminescence (PL) and high resolution X-Ray diffraction (XRD); the experimental WL transition energies were compared to simple model calculations of quantum energy levels. Our results show that the structural parameters extracted by XRD spectra simulations deviate from nominal values, as probably due to the growth parameters used to obtain low QD density [5]. The optical and structural properties of QDs were studied by means of PL, time-resolved PL (TRPL), Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM). TEM characterization was used to analyze the composition profiles in QDs, WL and UCLs; the results were related to the particular growth conditions used to prepare the structures. AFM measurements clearly evidenced on all samples bimodal distributions of QD heights that have been related to the observed double-peaked PL spectra. Optical characterization has been carried out as a function of temperature. Arrhenius plots of the integrated PL show two activation energies implying two decay processes. The first one is associated to thermal escape of carriers from the QDs to the WL states; the second one could be due to the presence of dark states, as suggested by TRPL measurements.
The results of this comprehensive characterization are useful to reach an in-depth understanding of the quantum system and its potential as a source of single photons.

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