FIB fabrication of InP-based quantum dot photonic structures for single photon emission in the telecom range

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The fabrication of integrated photonic structures, with embedded single quantum dot (QD) is subject of investigation which aims for optimization the emitters performance in terms of nonclassical light sources for quantum communication. We demonstrate the use of focused ion beam (FIB) technology on the contrary to commonly utilized the electron beam lithography technique to obtain significant photonic confinement [1,2]. This study explores the advantages of utilizing Xe-PFIB (Xenon Plasma Focused Ion Beam) technology in the fabrication of photonic structures, specifically focusing on InAs/InP semiconductor quantum dots with low surface density. By employing Xe-PFIB, non-deterministic and direct fabrication of structures is achieved without the need for protective masks. This approach minimizes the implantation effect, thereby reducing emission degradation through defect formation, which is often observed with Ga ions [3]. The research entails the processing and spectroscopy measurements of samples, wherein a series of mesas ranging from 3 to 5 μm in diameter were milled using a beam accelerating voltage of 10 kV and a beam current of 1nA. The fabricated microstructures are characterized using low-temperature micro-photoluminescence (μ-PL) measurements to assess the efficiency of quantum dot emission. Notably, the emission purity of single photons, including clear antibunching for charged exciton emission, is evaluated. Additionally, deterministic processing is attempted using PL imaging, enabling the preselection of suitable quantum dots for emission spectrally matched to 1.55 μm wavelength [4]. The study emphasizes the importance of optimizing processing steps to ensure efficient quantum dot emission while minimizing the potential destructive influence of ion beams on the crystal structure.

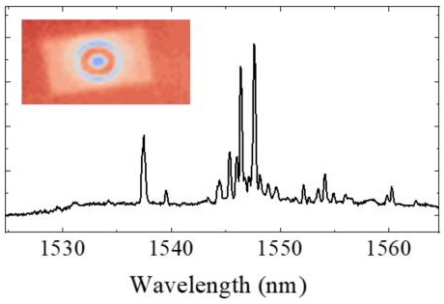

Figure1 Low-temperature μ-PL spectra from a single InAs/InP quantum dot selected by Xe-PFIB processed micro mesa structure

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