Quantum dots formation by InGaAs decomposition onto a patterned GaAs surface

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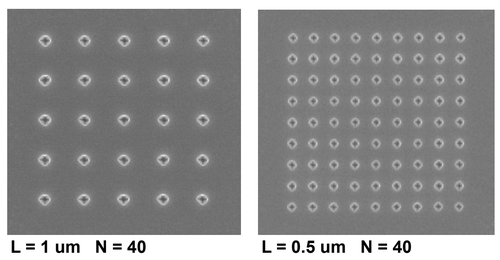
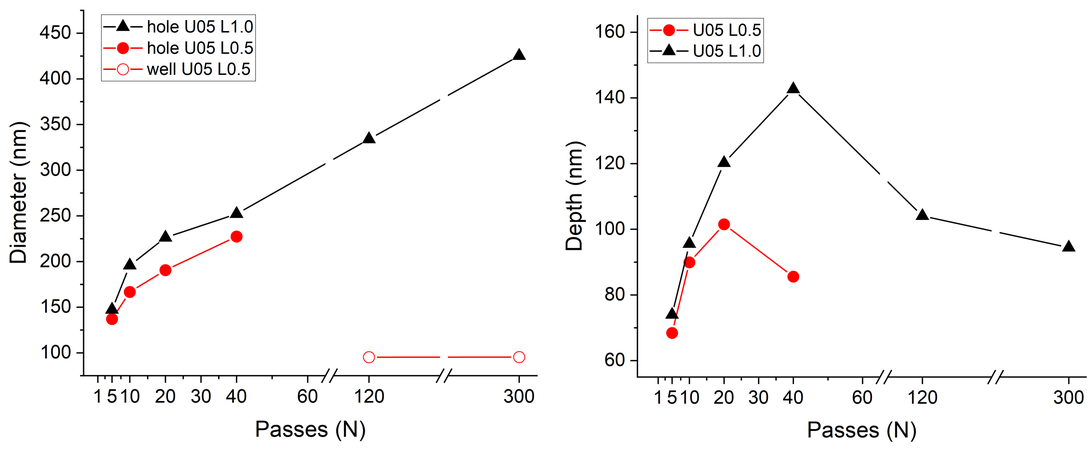
In this work, we present the results of experimental studies of the formation processes and optical properties of ordered arrays of InGaAs nanostructures obtained by layer of quantum well material deposition onto nanopatterned GaAs surface.

1 For GaAs nanopatterning we used a combination of focused ion beam treatment and local droplet etching techniques allowing to create arrays of holes with different morphology.

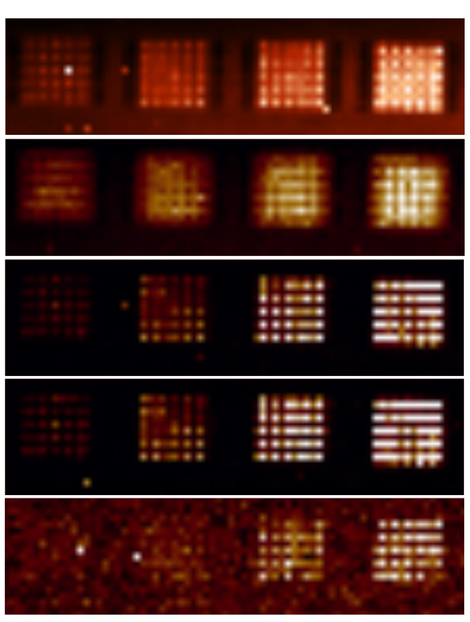
FIB parameters:
Accelerating voltage (U): 5 kV
Distance between holes (L): 0.5 and 1 um
Number of ion beam passes (N): 1 - 300 passes



Dependence of the diameter and depth of the formed holes on the number of passes

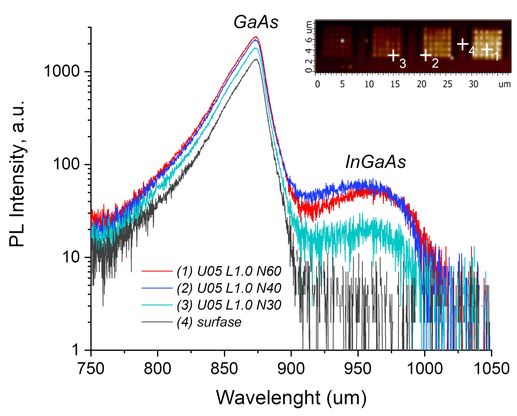


2 InGaAs layer (10 nm) with an indium content of 17% was deposited onto the structured surface GaAs. Using room-temperature photoluminescence (PL) mapping we have shown that quantum well material localizes inside the created holes.

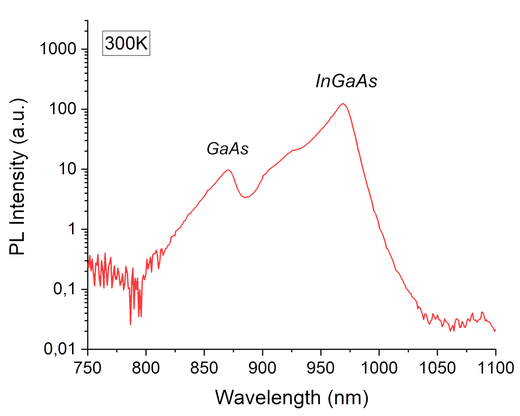


3 Position of corresponding PL peak (960 – 970 nm) is independent of morphology and is determined only by the chemical composition of the deposited material.

InGaAs on a structured surface



InGaAs on a flat surface



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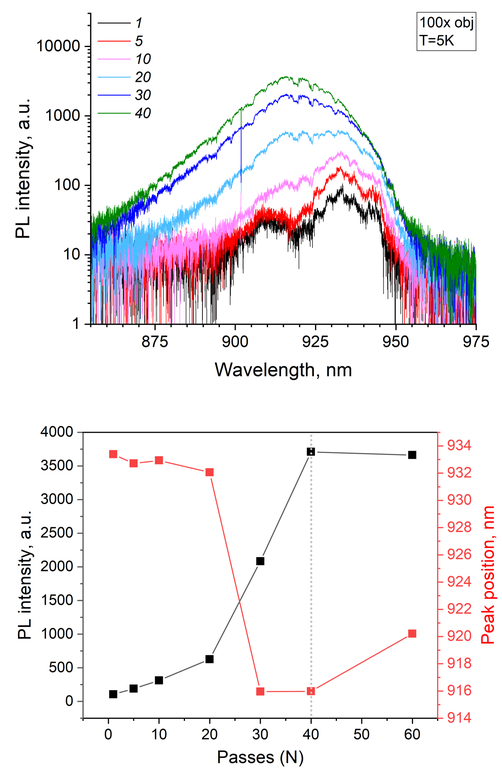
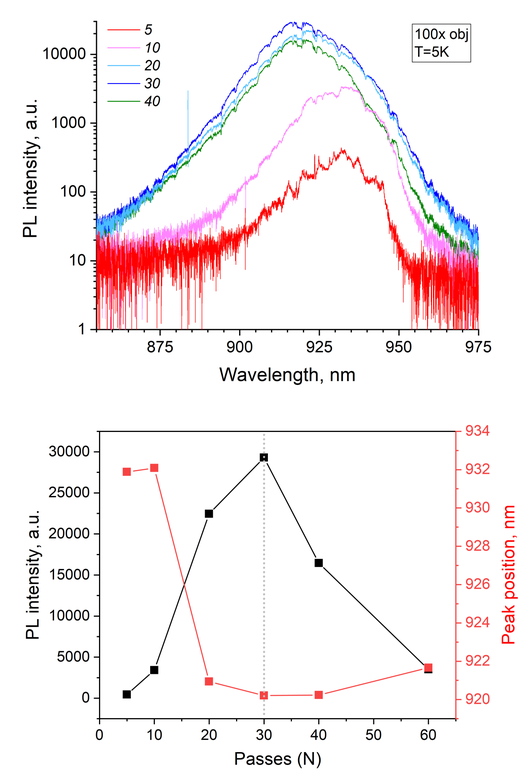
4 Based on low-temperature (5K) PL measurements we conclude that inside the holes quantum well decomposes due to the difference in a mobility of Ga and In adatoms during its material deposition with formation a "quantum well + quantum dot" system. While the quantum well peak locates approximately at 920 nm, the quantum dot lines lie in the wavelength range of 930 – 950 nm.

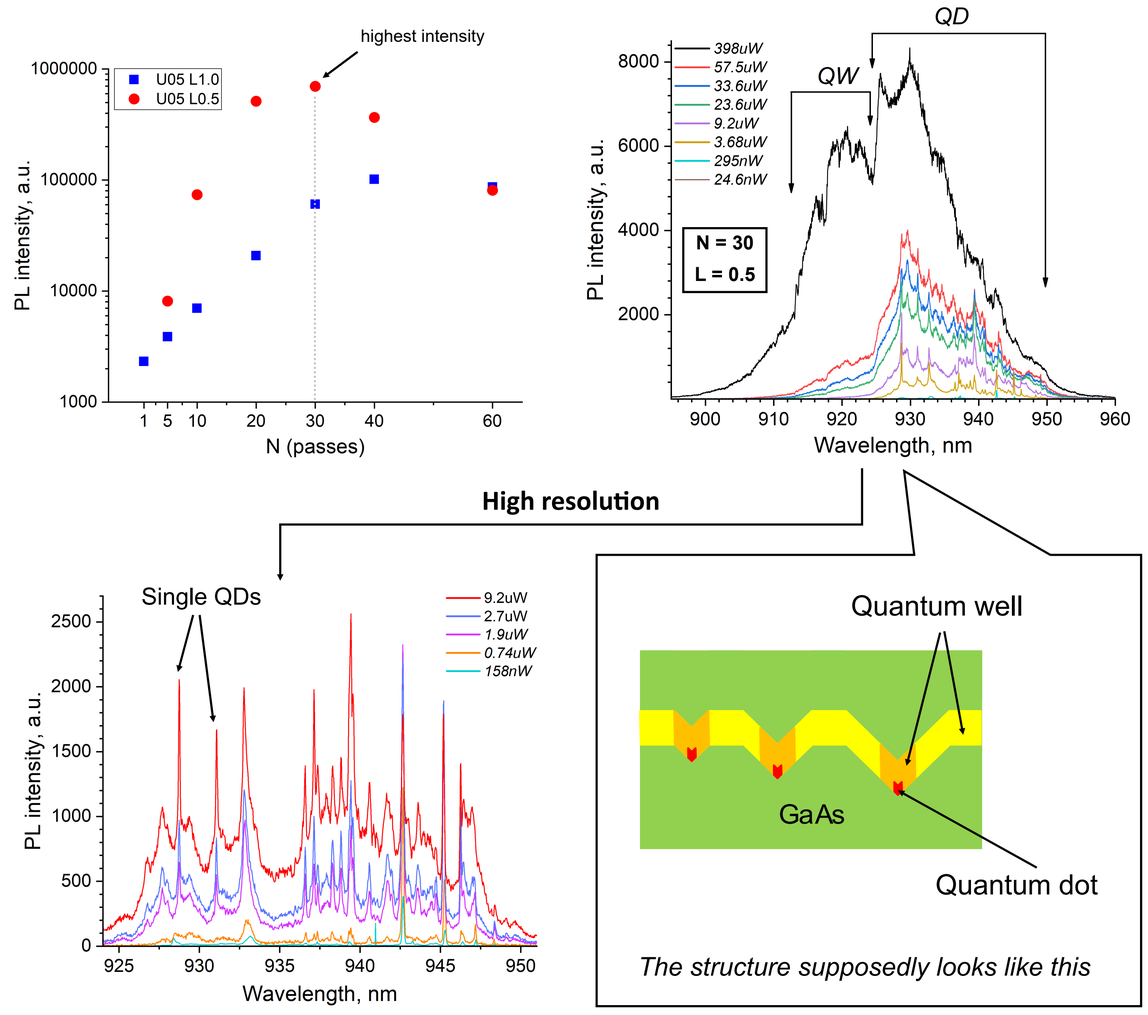
L = 1 um



L = 0.5 um



5 As a result, spectra were obtained with different excitation powers and high resolution, where the lines of individual quantum dots were visible.



6 **Conclusion:**

Thus, we have demonstrated for the first time the possibility of forming ordered arrays of QDs emitting in the wavelength range 930 – 950 nm by depositing an InGaAs QW layer onto nanopatterned GaAs surface. We have shown that inside pyramidal-shape holes InGaAs decomposes due to the difference in a mobility of Ga and In adatoms resulting in the formation a "quantum well + quantum dot" system.