Telecom C-band InAs quantum dots on metamorphic $In_xGa_{1-x}As$ buffer layers combining MOCVD and MBE growth

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Semiconductor quantum dots (QDs) emitting in the telecom C-band around 1.55 µm are promising solid-state sources of single and entangled photons for quantum communication applications. While on InP-substrates, InAs-QDs can be embedded in lattice-matched heterostructures for C-band emission, this requires on GaAs-substrates the use of a metamorphic buffer (MMB) layer, typically $In_xGa_{1-x}As$ with some grading profile for the In content. Here, the thin buffer layers with a convex In-profile and high, symmetric degree of relaxation demonstrated by metalorganic chemical vapor deposition (MOCVD) [1], are of great interest.

In this contribution, we present a hybrid approach that combines MOCVD and molecular beam epitaxy (MBE) to obtain InAs quantum dots emitting in the telecom C-band on GaAs. The metamorphic $In_xGa_{1-x}As$ buffer layer is grown by MOCVD to provide the required lattice relaxation, while the InAs QDs and the matrix are deposited by MBE. Fig. 1a shows a schematic of the heterostructure indicating which part has been MOCVD- and MBE-grown,

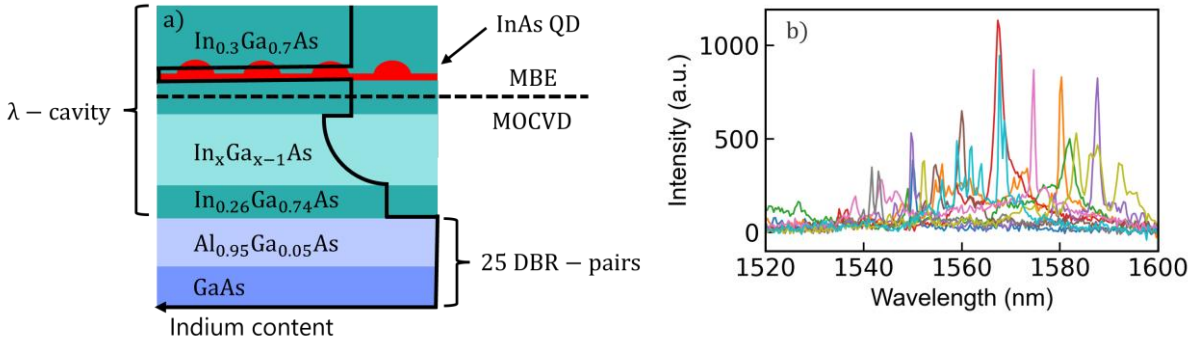

Figure 1: a) Schematic of the heterostructure indicating MOCVD and MBE-grown layers. b) Micro-photoluminescence spectrum of individual InAs quantum dots measured at T = 4 K, showing emission in the telecom C-band.

respectively. The MOCVD grown templates, prepared following a process outlined in [1], were transferred through air, chemically cleaned and introduced into the MBE system. First 45 nm $In_{0.3}Ga_{0.7}As$ were deposited at 310 °C employing As_2. This was followed by the deposition of InAs at 500 °C to form QDs in the Stranski-Krastanow growth mode. We deposited 0.7 to 1.7 monolayers and found QD formation down to 0.9 monolayers of InAs, which is surprisingly low. The density of the QDs decreased with decreasing InAs coverage. For optical characterization, the QDs were overgrown by 225 nm of $In_{0.3}Ga_{0.7}As$ at 310 °C.

Photoluminescence measurements revealed emission around 1.55 µm, with intensity decreasing with decreasing QD density. In micro-photoluminescence measurements performed at T = 4 K sharp emission lines that can be assigned to individual QDs could be observed for 0.9 monolayers coverage (see Fig. 1b).

[1] R. Sittig et al., Nanophotonics **11**, 1109 (2022).