Deterministic Circular Bragg Grating Integration for Electrically Tunable InAs Quantum Dot Molecules

Barbara Damasceno[1], Mohamed Helal[1], Giora Peniakov[1], Torsten Umlauf[1], David Laibacher[1], Matthias Sauter[1], Silke Kuhn[1], Dirk Reuter[2], Arne Ludwig[3], Tobias Huber-Loyola[1,4], Sven Höfling[1]

[1]*Julius-Maximilians-Universität Würzburg, Physikalisches Institut, Lehrstuhl für Technische Physik, Am Hubland, 97074 Würzburg, Germany*

[2]*Department of Physics, Paderborn University, Warburger Str. 100, 33098 Paderborn, Germany*

[3]*Experimental Physics VI, Faculty for Physics and Astronomy, Ruhr University Bochum, 44801 Bochum, Germany*

[4]*Karlsruhe Institute of Technology, Institute of Photonics and Quantum Electronics (IPQ) and Center for Integrated Quantum Science and Technology (IQST), 76131 Karlsruhe, Germany*

Pairs of optically active quantum dots coupled through quantum tunneling, commonly referred to as quantum dot molecules (QDMs), provide a promising platform for quantum information processing [1]. We present a design of a QDM-based sample (**Fig. 1(a)**) consisting of epitaxially grown self-assembled InAs quantum dots emitting around 930 nm. An $Al_{0.33}Ga_{0.67}As$ interlayer promotes strain-driven vertical alignment of the quantum dots, enabling coupled excitonic states and potential entanglement. The structure further incorporates a p-i-n diode for deterministic charge-state tuning. Preliminary voltage-dependent photoluminescence (PLV) measurements on the as-grown structures reveal possible anti-crossing features (**Fig. 1(b)**), suggesting coupling between individual quantum dots and the formation of a QDM. Then, the diodes were electrically characterized and investigated by hyperspectral imaging to pre-select emitters under fixed bias and excitation conditions. A deterministic integration of selected emitters into circular Bragg grating structures is envisaged to enhance photon extraction efficiency and improve the spectroscopic resolution of the coupled states [2,3]. This will enable a more precise investigation of the anti-crossing behavior and its underlying coupling mechanisms, representing a meaningful advance toward scalable quantum photonic devices for quantum communication.

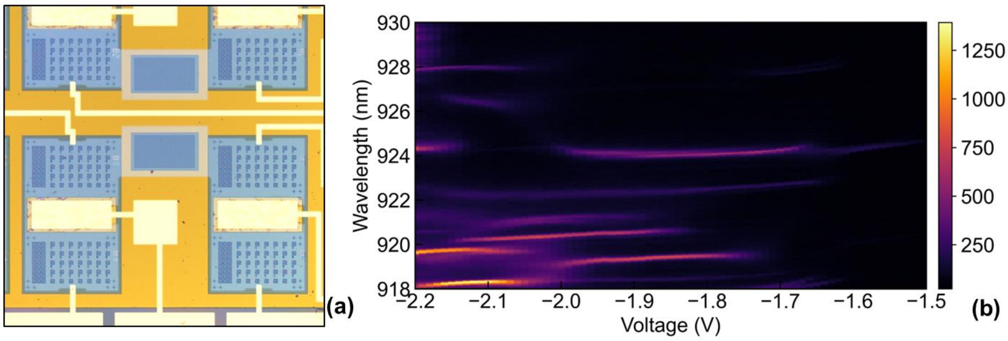

Fig. 1: *(a) Micrograph of the processed sample. (b) PLV heatmap exhibiting bias-dependent emission lines.*

Funding acknowledgement

The authors acknowledge the support of the Federal Ministry of Research, Technology and Space (BMFTR) within Projects QR.X (FKZ: 16KISQ010), QR.N (FKZ: 16KIS2209), and Qecs (FKZ: 13N16272)

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