Non-classical light sources with InAs/InP quantum dots as an emitter

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Non-classical light sources are a key resource in various fields of quantum technologies. One of the physical systems recognized as very promising quantum emitters are epitaxial quantum dots (QDs). In view of quantum communication, the emission in the 3rd telecommunication window is required for practical reasons of compatibility with existing fiber infrastructure minimizing optical losses. One of the possible material systems considered for this purpose is InP-based. InAs(P) QDs on this substrate offer emission in the telecom windows, but they have not yet reached the quality of their short emission wavelength GaAs counterparts. Therefore, there is a need for further development of this platform.

Hereby, current status of our study on InAs(P)/InP QDs emitting in the 3rd telecom window will be reported [1]. Investigated QDs are grown directly in InP matrix, without any ternary or quaternary barrier by exploitation of ripening-assisted molecular beam epitaxy growth [2,3]. Single QDs are isolated by photonic mesa structures and grown on top of the InGaAlAs/InP distributed Bragg reflector with over 95% reflectivity [4-6], which enhances the photon extraction efficiency up to 13% [7]. These are so far fabricated non-deterministically, but mesa design is optimized numerically [8]. Discussion of their (magneto)optical properties will focus on excitonic complexes [9,10] and their performance as sources of single photons [11] and pairs of entangled photons at 1550 nm. The prospect of realization of single-photon source operating at elevated temperatures will be discussed [12].

[1] M. Benyoucef and A. Musiał, Chapter 18: Telecom Wavelengths InP -Based Quantum Dots for Quantum Communication in Photonic Quantum Technologies: Science and Applications 2, 463, ed. M. Benyoucef, Wiley‐VCH GmbH, Hoboken, NJ (2023).

[2] M. Benyoucef, M. Yacob, J. P. Reithmaier, J. Kettler, P. Michler, Appl. Phys. Lett. **103**, 162101 (2013).

[3] M. Yacob, J. P. Reithmaier, M. Benyoucef, Appl. Phys. Lett. **104**, 22113 (2014).

[4] A. Kors, J. P. Reithmaier, M. Benyoucef, Appl. Phys. Lett. **112**, 172102 (2018).

[5] A. Musiał, M. Wasiluk, M. Gawełczyk, J. P. Reithmaier, M. Benyoucef, G. Sęk, W. Rudno-Rudziński, Phys. Status Solidi–R **17**, 2300063 (2023).

[6] A. Zielińska, A. Musiał, P. Wyborski, M. Kuniej, T. Heuser, N. Srocka, J. Grosse, J. P. Reithmaier, M. Benyoucef, S. Rodt, S. Reitzenstein, W. Rudno-Rudziński, Opt. Express **30**, 20225 (2022).

[7] A. Musiał, M. Mikulicz, P. Mrowiński, A. Zielińska, P. Sitarek, P. Wyborski, M. Kuniej, J. P. Reithmaier, G. Sęk, M. Benyoucef, Appl. Phys. Lett. **118**, 221101 (2021).

[8] P. Mrowiński, G. Sęk, J. Condens. Matter Phys., **562**, 141 (2019).

[9] P. Podemski, M. Gawełczyk, P. Wyborski, H. Salamon, M. Burakowski, A. Musiał, J. P. Reithmaier, M. Benyoucef, G. Sęk, Opt. Express **29**, 34024 (2021).

[10] W. Rudno-Rudziński, M. Burakowski, J. P. Reithmaier, A. Musiał, M. Benyoucef, Materials **14**, 942 (2021).

[11] A. Musiał, P. Holewa, P. Wyborski, M. Syperek, A. Kors, J. P. Reithmaier, G. Sęk, M. Benyoucef, Adv. Quantum Technol. **3**, 1900082 (2020).

[12] T. Smołka, K. Posmyk, M. Wasiluk, P. Wyborski, M. Gawełczyk, P. Mrowiński, M. Mikulicz, A. Zielińska, J. P. Reithmaier, A. Musiał, M. Benyoucef, Materials **14**, 6270 (2021).