Downloaded from orbit.dtu.dk on: Dec 01, 2021

DTU Library

Strain spectrally-tunable single-photon source based on a quantum dot in micro-cavity

Moczaa-Dusanowska, Magdalena; Dusanowski, ukasz; Gerhardt, Stefan; He, Yu-Ming; Reindl, Marcus; Rastelli, Armando; Trotta, Rinaldo; Gregersen, Niels; Höfling, S.; Schneider, C.

Published in:
Proceedings of SPIE

Publication date:
2021

Document Version
Peer reviewed version

Link back to DTU Orbit

Citation (APA):
Moczaa-Dusanowska, M., Dusanowski, ., Gerhardt, S., He, Y-M., Reindl, M., Rastelli, A., Trotta, R., Gregersen, N., Höfling, S., & Schneider, C. (Accepted/In press). Strain spectrally-tunable single-photon source based on a quantum dot in micro-cavity. In *Proceedings of SPIE* SPIE - International Society for Optical Engineering.

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Strain spectrally-tunable single-photon source based on a quantum dot in micro-cavity

M. Moczała-Dusanowska[1], Ł. Dusanowski[1], S. Gerhardt[1], Y.M. He[2], M. Reindl[3], A. Rastelli[3], R. Trotta[3,4], N. Gregersen[5], S. Höfling[1,6], and C. Schneider[1]

[1] *Technische Physik and Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Physikalisches Institut, Würzburg University, Am Hubland, Würzburg, Germany*
[2] *Hefei National Laboratory for Physical Sciences, University of Science and Technology of China, Hefei, Anhui 230026, China*
[3] *Institute of Semiconductor and Solid State Physics, Johannes Kepler University, Altenbergerstr. 69, 4040 Linz, Austria*
[4] *Department of Physics, Sapienza University of Rome, Piazzale Aldo Moro 5, Rome, Italy*
[5] *DTU Fotonik, Department of Photonics Engineering, Technical University of Denmark, Ørsteds Plads 343, 2800 Kongens Lyngby, Denmark*
[6] *SUPA, School of Physics and Astronomy, University of St Andrews, St Andrews, UK*

100-word abstract

Epitaxially grown self-assembled quantum dots (QDs) are promising candidates for an efficient single-photon generation. In order to maximize the number of photons extracted from the device, QDs are frequently embedded into photonic structures such as micro-cavities. Once the QD is positioned inside an optical cavity, the Purcell effect ensures that light is emitted predominantly into the cavity mode.
In this contribution, we demonstrate results of emission tuning of QDs inserted in micro-cavities. A sample containing an InAs/GaAs QDs embedded in a planar cavity based on Bragg reflectors has been integrated onto the PMN-PT piezo crystal. Subsequently, micro-cavities have been fabricated by electron-beam lithography and reactive ion etching.
The application of external stress produces linear shifts of QDs emission which could be tuned into the resonance with fundamental cavity mode and allow enhancement of QD emission due to the Purcell effect.

250-word abstract for technical review by the Chairs/Committee.

Scalable quantum photonic architectures demand highly efficient, high-purity single-photon sources, which can be frequency matched via external tuning. Among different kinds of quantum emitters, epitaxially grown self-assembled quantum dots (QDs) have been shown to be one of the leading candidates for an efficient single-photon generation. In order to maximize the number of photons extracted from the device, QDs are frequently embedded into photonic structures such as micro-cavities. Once the QD is positioned inside an optical cavity, the Purcell effect ensures that light is emitted predominantly into the cavity mode. However, the exploitation of the Purcell effect requires careful spectral alignment of the QD emission and the cavity mode lines.
We demonstrate a single-photon source based on an InAs quantum dot embedded in a micropillar resonator, which is frequency tunable via externally-applied stress. Our platform combines the advantages of a Bragg micropillar cavity and the piezo-strain-tuning technique enabling single photon spontaneous emission enhancement via the Purcell effect and

quantum dot (QD) with tunable wavelength. Our optomechanical platform has been implemented by integration of semiconductor-based QD-micropillars on a piezoelectric substrate. A quantum dot emission energy tuning range of 0.75 meV for 27 kV/cm applied to the piezo substrate has been achieved. The fabricated device exhibits spontaneous emission enhancement with a Purcell factor of 4.4±0.7 and allows for a pure triggered single-photon generation with $g(2)(0) < 0.07$ under resonant excitation.

[1] Moczała-Dusanowska, M. *et al.* Strain-Tunable Single-Photon Source Based on a Quantum Dot–Micropillar System. *ACS Photonics* acsphotonics.9b00481 (2019). doi:10.1021/acsphotonics.9b00481