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

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