Cavity-enhanced emission from localized excitons in deterministically nanostrained WSe_2 monolayer

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The bright and ease-to-fabricate single-photon source is at the heart of scalable quantum communication where the data is safely encrypted using quantum nature of the light. To date semiconductor quantum dots (QDs) are the most advanced quantum light source in solids. Recently strongly localized excitons in two-dimensional semiconductors have emerged as bright quantum emitters possessing spectrally narrow spectral lines and high purity of single photons [1,2].

Here we show how engineering of dielectric circular Bragg grating cavity can make site-controlled QDs in WSe_2 monolayers (MLs) prospective platform for scalable quantum information processing. In order to match cavity resonance with QD emission, optimize extraction efficiency as well as Purcell factor F_p such a bullseye (BE) cavity was simulated using finite difference time domain (FDTD) calculations. The optimized design provides F_p about 10 at the cavity resonance while highly directional guided transmission reaches more than 60 percent in a wide spectral range.

QDs were deterministically seeded as a result of tenting of the WSe_2 ML around platinum nanopillar deposited in the center of the cavity. Spatially resolved photoluminescence (PL) spectroscopy shows that in addition to cavity-enhanced broadband emission of free excitons in ML point defects with a spectrally narrow bright emission appear inside the cavity.

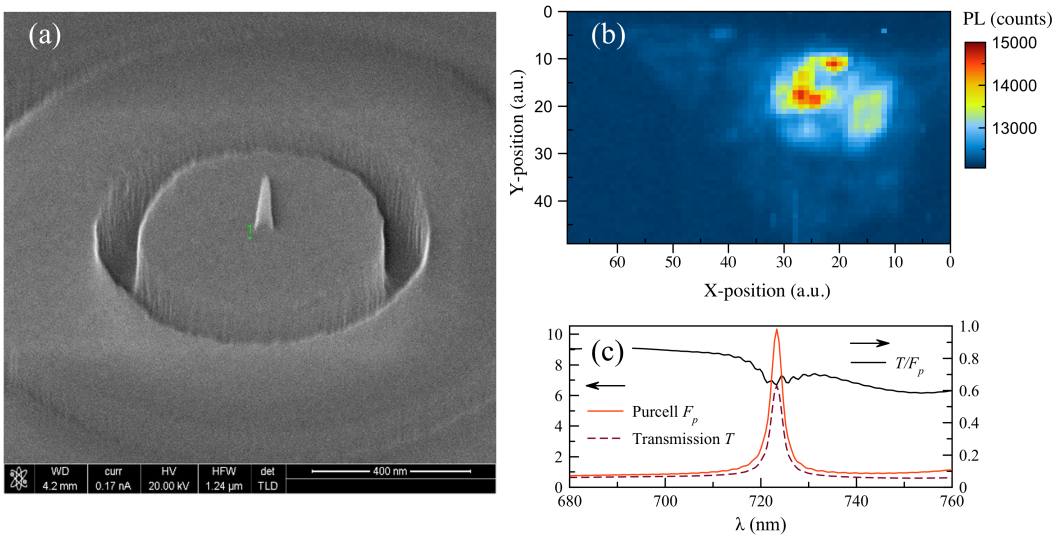

Figure. (a) Scanning electron microscope image of a Pt pillar in the center of a bullseye cavity. (b) PL map of WSe_2 ML transferred on the cavity. (c) FDTD simulation of Purcell factor F_p and normalized transmission T/F_p for a BE cavity.

[1] J.C. Drawer, V.N. Mitryakhin et al., Nano Lett. **23**, 8683 (2023)
[2] O. Iff at al., Nano Lett. **21**, 4715 (2021)