Active control of single photon sources using 2D materials

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Solid state quantum emitters are a mainstay of quantum nanophotonics as integrated single photon sources (SPS) and optical nanoprobes[1,2]. Integrating such emitters with active nanophotonic elements is desirable in order to attain efficient control of their optical properties but typically degrades the photostability of the emitter itself[2]. In our group, we have developed optomechanical[3] and optoelectrical[4] approaches to either tune energy and decay rate of single photon sources. In this talk, I will present recent experiments[4] that demonstrate a tuneable hybrid device which integrates lifetime-limited single emitters (linewidth: 40 MHz) and 2D materials at sub-wavelength separation without degradation of the emission properties. Our device's nanoscale dimensions enable ultra-broadband tuning (tuning range > 400 GHz) and fast modulation (frequency: 100 MHz) of the emission energy, which renders it an integrated, ultra-compact tuneable SPS. Conversely, this offers a novel approach to optical sensing of 2D material properties using a single emitter as a nanoprobe.

References

[1] Benson. Assembly of hybrid photonic architectures from nanophotonic constituents. Nature 480, 193 (2011)

[2] Moerner et al. Single-Molecule Optical Detection, Imaging and Spectroscopy. (Wiley, 2008).

[3] Reserbat-Plantey, A. et al. Nature Communications. 7, 10218 (2016).

[4] Schädler et al. submitted. (2018)

Figures

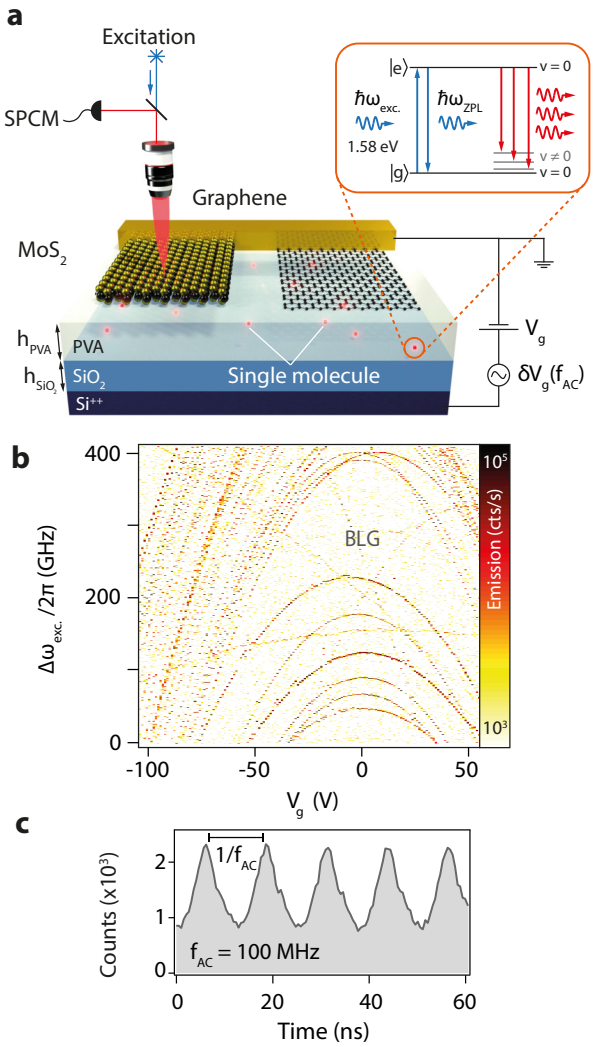

Figure 1: Stark tuning of a single molecule with a 2D electrode. **a**: graphene and MoS_2 top electrodes for electrostatic tuning of fluorescent molecules. **b**: Stark shift of an ensemble of single molecules under graphene electrode. **c**: Histogram of time-resolved single molecule emission intensity modulation (100 MHz).