Deterministic strain-induced arrays of quantum emitters in a two-dimensional semiconductor.

Art Branny
Santosh Kumar, Raphaël Proux, and Brian D. Gerardot
Institute of Photonics and Quantum Science, SUPA, Heriot-Watt University, Edinburgh, UK
Ak296@hw.ac.uk

An outstanding challenge in quantum photonics is scalability, which requires positioning of single quantum emitters in a deterministic fashion. Site positioning progress has been made in established platforms including defects in diamond[1] and self-assembled quantum dots[2] albeit often with compromised coherence and optical quality. The emergence of single quantum emitters in layered transition metal dichalcogenide semiconductors[3] offers new opportunities to construct a scalable quantum architecture.

Here, using nanoscale strain engineering, we deterministically achieve a two-dimensional lattice of quantum emitters in an atomically thin semiconductor[4]. We create point-like strain perturbations in mono- and bi-layer WSe_2 which locally modify the band-gap, leading to efficient funnelling of excitons[5] towards isolated strain-tuned quantum emitters that exhibit high-purity single photon emission[6]. These arrays of non-classical light emitters open new vistas for two-dimensional semiconductors in cavity quantum electrodynamics and integrated on-chip quantum photonics.

References

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Figures

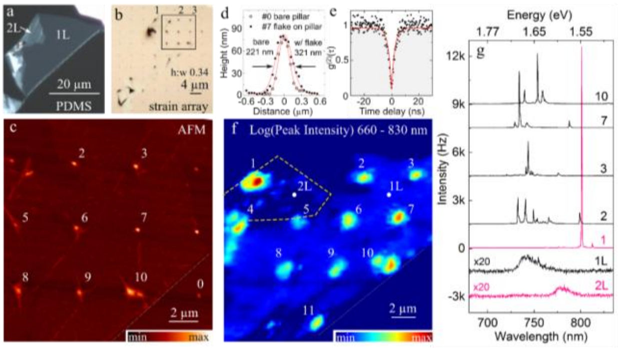

Figure 1: Optical micrographs of an exfoliated 1L WSe_2 flake (a) before and (b) after transfer onto a Si substrate with an array of dielectric nanopillars. The black box in (b) identifies the nanopillars covered by the 1L region. (c) AFM image of the topography of the flake on top of the nanopillars, revealing a lattice of locally strained points. (d) Cross-section AFM profile of a bare nanopillar #0 and nanopillar #7 that is covered by the monolayer. (e) Second-order photon correlation statistics from a typical 1L quantum emitter revealing clear antibunching [g(2)(0) = 0.067 ± 0.039 and tau = 2.83 ± 0.15 ns]. (f) Color-coded spatial map of the integrated PL signal in the spectral range of 660 − 830 nm. (g) Example PL spectra of isolated quantum emitters at the pillar locations as labelled. Also shown is the weak signal from the unstrained 1L and 2L WSe_2.