In search of controlled single photon emission sites in monolayer transition metal dichalcogenides

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Abstract

Single photon emission (SPE) from WSe2 and MoSe2 has recently been demonstrated under both optical and electrical pumping. However, the origin of this emission is still unknown. In this work, we study photoluminescence from exfoliated WSe2. We find that SPE is observed primarily along the edges of monolayers, including borders with thicker layers. While the properties of the emitted light are consistent with those reported by others, we find that the density and stability of SPE sites depends on the sample preparation method used.
In an attempt to gain insight into the origin of the emission sites, we use off-axis electron holography in the transmission electron microscope and density functional theory calculations to correlate the electron phase measured using electron holography with the bare electrostatic potential in a monolayer WSe2 crystal. Since the phase can be measured with atomic resolution, we assess the conditions under which point defects (including vacancies and substitutional atoms) can be detected based on their electrostatic potentials using electron holography. We also discuss the possibility of localizing excitons on substitutional atoms (such as, Se in MoS2) or in lateral heterostructures.