Electrically gated single photon emitters in monolayer transition metal dichalcogenides

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Monolayers of transition metal dichalcogenides (TMDs) draw much attention as semiconducting materials with robust optical properties, strong Coulomb interaction, and an optically accessible valley degree of freedom. While some of the questions related to excitation dynamics and other electronic properties of the pristine TMDs are still to be answered, much attention is drawn to the more specific system based on ultrathin layers of TMDs. In recent years, significant research efforts have been directed to quantum emitters formed on various carrier localization centers in TMDs. Such objects are characterized by small linewidth, long luminescence lifetime, and single-photon emission. Related sharp emission lines are visible among or energetically below the band of relatively broad non-localized excitonic states. Such objects can be observed in monolayers or bilayers of several different TMDs. Single photon emitters (SPEs) are interesting from the point of view of photonics. Their properties, combined with the extraordinary properties of the free excitonic states in atomically thin TMDs, can open up perspectives for many advances in photonics and optoelectronics. However, these possibilities are currently hindered by a need for a more thorough understanding of the excitonic structure of the SPEs.

In this work, we identify and study SPEs created on different types of localized centers, particularly point defects and strain centers. Following Ref. [1], we expect that the Zeeman shift amplitudes should strongly depend on the nature of the trapping state, allowing identification of the SPEs localized on different types of defects. We investigate the SPE states in the TMD monolayers and determine the statistically most prevalent mechanism of carrier localization. We find, that in case of the WSe_2 monolayer the hole trapping is the most prevailing mechanism, although emitters based on electron trapping can also be observed. Furthermore, control over the Fermi level facilitated by the electrical gating in the sample allows for estimating the energy of the doping states responsible for the localizing center in the TMD layer.

[1] J. Dang et. al., *Npj 2D Mater. Appl.* **4**, 1 (2020).