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Quantum emitters in monolayer WSe_2 on nano-roughness glass substrates

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Abstract

Two-dimensional (2D) transition metal dichalcogenides (TMDs) are attractive systems with strong spin-valley coupling and excitonic effects [1,2,4]. Local-strain and defects engineering in TMDs play an important role in their optical properties, particularly for generating atomic defect-based single-photon emitters, which are the platform to develop on-chip integrated single-photon sources for quantum information technology [1,4]. Here, we have investigated optical and magneto-optical properties of monolayer WSe_2 on nano-roughness Tb^{3+} - borogermanate glasses substrates with different Tb^{3+} content. We have observed several sharp emission peaks which were associated with localized excitons from strained regions in the ML WSe_2 due to the presence of nano-roughness on the glass substrate. Furthermore, we have performed a detailed study of low-temperature magneto-photoluminescence measurements under parallel and perpendicular magnetic fields. Remarkably, our results reveal several stable sharp doublet emissions that were associated with the anisotropic electron-hole exchange interaction with g-factors close to the values observed for dark states in the monolayer WSe_2. Furthermore, it was observed that density of these doublet emissions depends of the Tb^{3+} content. In addition under parallel magnetic field, we have observed a clear red shift of these emission peaks with increasing magnetic field. In general, our findings open interesting opportunities to generate a controlled density of QD-like emissions in WSe_2 on nano-roughness glasses using a lithography-free approach for possible integration with photonic devices.

References

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