Optical and Magneto-Optical Properties of Localized Excitons in Monolayer WSe_2 on Nano-Roughness Glass Substrates

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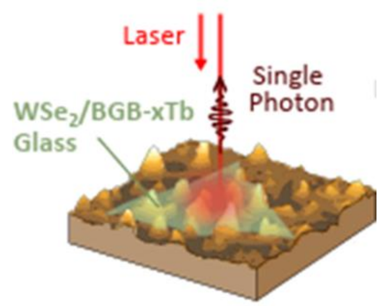

Fig.1.Schematic representation of the monolayer WSe_2/glass substrate.

Strain and defects engineering in transition metal dichalcogenides (TMDs) play an important role in controlling their excitonic and valleys properties. Particularly, the control of strain and defects can be used for generating atomic defect-based single-photon emitters, which are the platform to develop on-chip integrated single-photon sources for quantum information technology. In this work, we investigate optical and magneto-optical properties of a monolayer WSe_2 on Tb^{3+} borogermanate glasses with different Tb^{3+} concentrations. Our results show that by using a simple lithography-free approach, it is possible to generate nano-roughness glass surfaces to localize excitons by local strain in a monolayer WSe_2. Furthermore, we show that the density of these localized excitons can be controlled by the amount of Tb^{3+} doping of these glasses. Remarkably, the photoluminescence (PL) reveal several stable sharp doublet emission peaks with small line jittering effects and with typical fine-structure splittings of ≈ 760 μeV from the same quantum dot (QD)-like emitters which are associated with an anisotropic electron–hole exchange interaction. Moreover, the auto-correlation function is measured for these emission lines and displays non-classical light emission, evidenced by pronounced photon antibunching. In order to investigate in more detail the nature of these localized excitons, we investigate the circularly polarization-resolved PL under magnetic field (Faraday and Voigt configurations). Under perpendicular magnetic field, the extracted g-factor values for these PL peaks are ~8.4–9.8 which is consistent to the interpretation of localized dark emissions in WSe_2. Under parallel magnetic field, a clear red-shift of emission peaks with increasing magnetic field is observed which is probably due to the magnetic field induced splitting of dark and bright emission branch. In general, our results suggest that nano-rough engineering on glass substrates is a promising tool to control optical properties of single emitters for possible integration with photonics systems in quantum information technology.

References

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