Defect and Strain Engineering of Quantum Confinement in WSe_2/β-Ga_2O_3

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Two-dimensional (2D) transition metal dichalcogenides (TMDs) materials are attractive systems with strong spin-valley coupling and excitonic effects [1,2]. Nano-strain and defects engineering in TMDs play an important role in controlling their optical properties, particularly for generating atomic defect-based single-photon emitters, which are the platform for the development of on-chip integrated single-photon sources for quantum technology [1,2]. Monoclinic gallium oxide (β-Ga_2O_3) is an ultra-wide bandgap semiconductor with increasing interest for possible applications in power electronics and UV optoelectronics. Despite of not being a van der Waals material and having highly strong ionic bonding, the β-Ga_2O_3 crystal can be mechanically exfoliated along the (100) favorable surfaces to make ultra-thin layers for device fabrication and nanotechnology [3]. Here, we have investigated optical and magneto-optical properties of a monolayer (ML) WSe_2/β-Ga_2O_3 flakes on SiO_2 under out-plane magnetic field [4]. Remarkably, we observed that the Ga_2O_3 improves the optical properties of ML WSe_2 at low temperatures reducing the doping and PL linewidth of emission peaks. Furthermore, several sharp emission peaks were also observed and have shown valley g-factors values close to -4 which is an unusual result for localized excitons in ML WSe_2. Moreover, additional PL peaks with higher g-factor values of ≈ -7 and ≈ -12 were also observed and associated with the hybridization of strain localized dark excitons and defects. In general, our work provides fundamental insights on the impact of exfoliated Ga_2O_3 substrates and point defects on the optical and magneto-optical properties of monolayer WSe_2/Ga_2O_3/SiO_2 heterostructures. Our results are particularly relevant for the development of devices in opto-electronics and possible applications in quantum information technology [4].

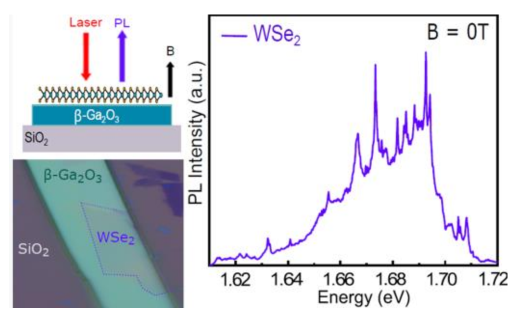

Fig.1. Schematic representation and optical microscope image of the WSe_2/β-Ga_2O_3 heterostructure and typical PL spectrum at zero magnetic field [4].

References

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