Optical cavities for WSe_2 monolayers

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Thin layers of transition metal dichalcogenides like MoS_2, $MoSe_2$, WS_2, or WSe_2 have recently emerged as a new class of materials that show great potential in optoelectronics. Of particular importance for device applications are their monolayer forms which exhibit a direct bandgap that gives rise to pronounced emission of light. Emission form the monlolayer can be enhanced by its incorporation with the optical cavity as it was shown for MoS_2 [1,2].

In this work we demonstrate a design of an optical cavity optimized for monolayers of WSe_2. Our cavity comprises two dielectric mirrors composed of subsequent SiO_2/TiO_2 layers, whose parameters have been established in the course of numerical simulations based on a transfer matrix method. The whole structure has been designed in a way to obtain the maximum electric field exactly at the position of the monolayer, which should ensure the most effective coupling conditions.

Before fabricating a complete cavity with the WSe_2 monolayer in the middle, we first realized a half-cavity structure. Single flakes of WSe_2 deposited on top of the bottom dielectric mirror are shown in Fig. 1a. The emission from the single WSe_2 layer is shown in Fig. 1b. The quality and tunability of the complete but empty cavity (with no flakes between the mirrors) are illustrated in Fig. 1c, which demonstrates the reflectivity spectra of two mirrors brought into mechanical contact and subjected to stress of different intensity. The position of the narrow resonance in the stop-band region can be conveniently tuned by adjusting the force acting on the cavity. The mechanical tuning of the resonance emerges therefore as a possible approach to provide the match between the resonance and the energy of the excitons in WSe_2 monolayers.

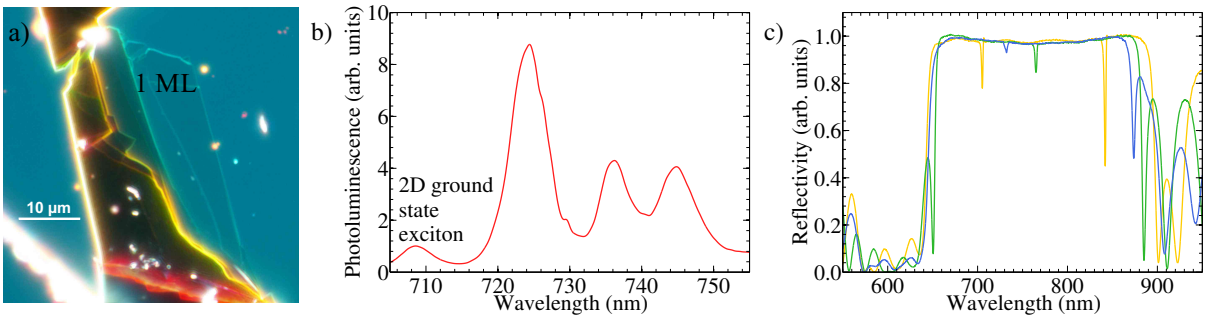

Figure 1: a) Dark field image of a WSe_2 layers deposited on a half-cavity. Single layer is visible as a matt triangular shape. b) Photoluminescence spectrum of a single WSe_2 flake at the half-cavity (T = 4.2 K). c) Reflectivity spectra of SiO_2/TiO_2 cavity with different stress applied to it (T = 300 K).

[1] S. Schwarz et al., *Nano Lett.* **14**, 7003 (2014). [2] X. Liu et al., *Nat. Photonics* **9**, 30 (2015)

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