WSe_2 monolayers in dielectric cavities

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Thin layers of transition metal dichalcogenides (TMDs) such as MoS_2, WS_2 or WSe_2 have recently attracted considerable attention. Single layers of TMDs exhibit a direct band-gap, which make them a very appealing group of materials with potential applications in opto-electronic devices. We demonstrate a possible realization of optical cavities designed for one particular representative of this group i.e. for tungsten diselenide, WSe_2.

In our work we present the processing and optical properties of dielectric cavities incorporating WSe_2 monolayers. The procedure of sample fabrication consists of two independent growth processes of subsequent TiO_2 and SiO_2 layers which constitute two distributed Bragg reflectors (DBRs) and a $\lambda/2$ SiO_2 cavity. After completing the first DBR terminated by the bottom half of the cavity, exfoliated monolayers of WSe_2 are deposited on its top surface by means of an all-dry polydimethylsiloxane-based transfer technique, and then the second half of the cavity along with the top DBR are grown. Previously performed numerical simulations based on transfer matrix method gave us widths of dielectrics layers needed to achieve desired samples properties. The cavity mode energy at liquid helium temperature should be close to the exciton resonance in 1 ML-thick WSe_2 with the maximum of the electric field amplitude exactly at the position of the monolayer. Microscopic images of a selected sample in Fig. a demonstrate that WSe_2 monolayers are not affected by the growth process of the top DBR. Shown in Fig. b are measured reflectance spectra at cryogenic temperatures that gave us the cavity mode at an energy of 1.74 eV, which is very close to that of 2-D excitons in WSe_2 monolayers (1.75 eV).

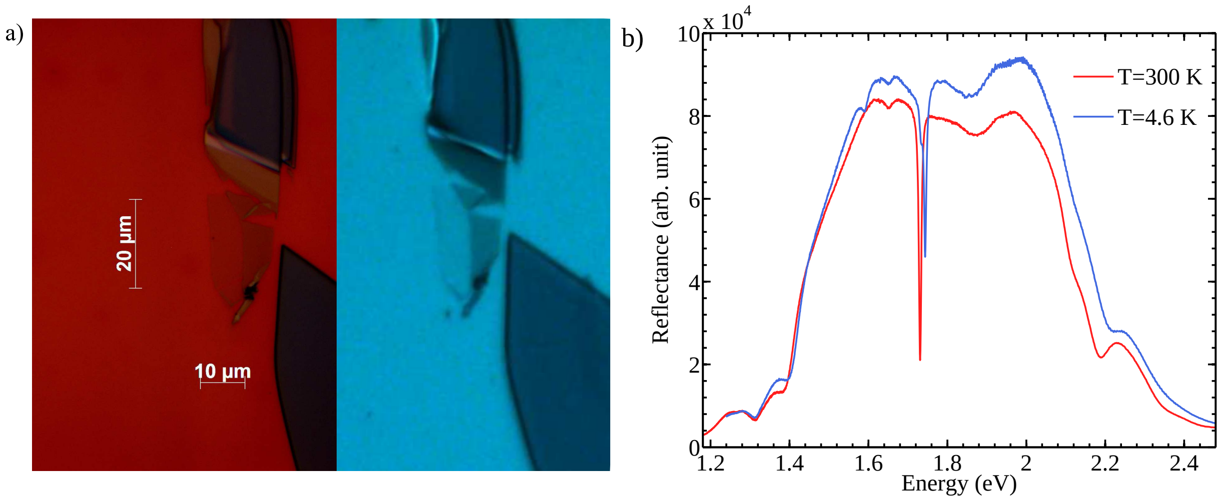

Figure: a) Image of a WSe_2 single layer before (left) and after (right) growth of the top DBR b) reflectance spectra in low and high temperature from cavity structure in the vicinity of the WSe_2 single layer.