# Photoluminescence from the $WSe_2$ monolayers embedded in dielectric cavities

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Thin layers of transition metal dichalcogenides atomic crystals (TMDCs) have recently emerged as a new class of materials with a number of valuable optical properties. Monolayers of semiconducting TMDCs, i.e. $MoS_2$, $WS_2$, $WSe_2$ and $MoTe_2$ exhibit a direct bandgap with a very high exciton binding energy and large exciton oscillator strength. These properties make them very promising materials to study light-matter coupling [1] with the observation of the strong coupling regime already reported in the literature [2].

Our studies are concentrated on tungsten diselenide ($WSe_2$) monolayers placed in optical cavities. The role of the cavity is to maximize the overlap between the excitonic wave-function and the photon electric field in order to enhance the light-matter coupling. We proposed and examined two separate designs of the cavities based on $SiO_2/TiO_2$ distributed Bragg reflectors (DBRs) with $WSe_2$ monolayers placed between them.

Initial stages in the sample fabrication are the same for both of our designs. A dielectric DBR structure is grown on a transparent substrate like fused silica. The $SiO_2/TiO_2$ layers thicknesses are chosen to match the photonic stopband's energy range to the exciton transition energy in the $WSe_2$ monolayer. Exfoliated $WSe_2$ monolayers are deposited on the top surface of the DBR by means of an all-dry polydimethylsiloxane- based transfer technique.

Afterwards in the first realization full-cavity can be assembled by simply placing another part of the same DBR on the bottom DBR that has been previously decorated with TMDC monolayers. With no separation between the two DBRs, microcavity with the maximum of the electric field at the position of the monolayer is formed. When subjected to an angle-resolved photoluminescence experiment at liquid helium temperature such a structure displays a emission intensity increase at the crossovers between the cavity photon mode and the localized exciton transitions which suggests achieving the weak coupling regime. Additionally, multiple cavity photon modes are observed. The reflection measurement in the wide spectral range allows to estimate the distance between two DBRs forming full-cavity to around 5 $\mu$m.

In the second structure, on top of the $WSe_2$ monolayer second DBR is grown starting from an $SiO_2$ layer. The angle-resolved photoluminescence experiment shows this time a single cavity photon mode with the energy close to the exciton energy in $WSe_2$. Depending on the position on the monolayer the emission spectrum significantly changes showing two branches. The possibility of observing strong light-matter interaction in this system is discussed.

[1] J.-H. Jiang *et al.*, *Phys. Rev. X* **4**, 031025 (2014). [2] X. Liu *et al.*, *Nat. Phot.* **9**, 30 (2015).

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