ELECTRICALLY DRIVEN SINGLE PHOTON SOURCES IN ATOMICALLY THIN SEMICONDUCTORS

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Two dimensional materials provide a genuine toolkit for novel opto-electronic devices [1,2]. In particular, transition metal dichalcogenides (TMD, such as MoS_2, $MoSe_2$, $MoTe_2$, WS_2, WSe_2) are endowed with peculiar optical, spin and valley properties, especially when they are thinned down to the monolayer limit [2]. It has recently been shown that such atomically thin semiconductors can host isolated quantum emitters (e.g. attributed to localized defects) that can be optically or electrically driven to produce bright single photon sources [3]. In spite of these recent breakthroughs, the nature of the defects that give rise to non-classical emission as well as the possibility to engineer the latter remain largely unexplored.

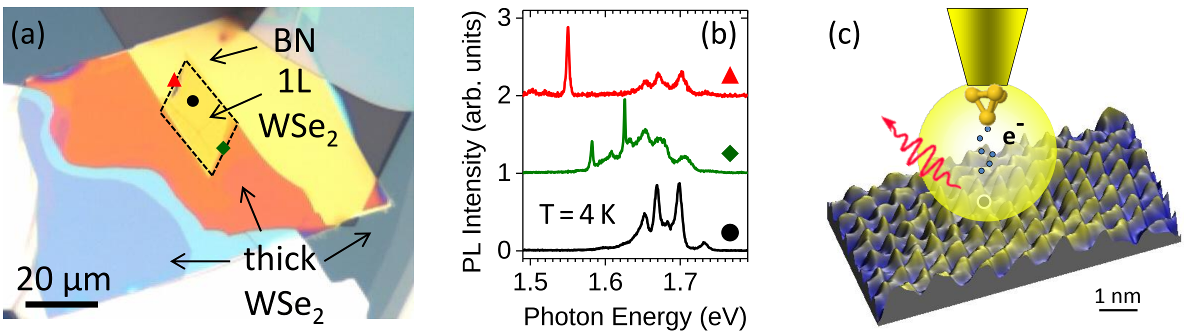

Figure 1 - (a) Optical Image of a WSe_2 flake deposited on atomically smooth boron nitride (BN). (b) The micro-photoluminescence (PL) spectra recorded at the edges of a monolayer WSe_2 (dashed contour) display sharp lines (red and green spectra) that are attributed to "quantum-dot-like" emitting sites. Such lines are absent in the reference spectrum (black line) recorded near the center of the monolayer. (c) Atomically-resoled STM image of a single layer $MoSe_2$ flake and artist's view of STM-induced electroluminescence. All data recorded at IPCMS.

This project aims at probing and controlling the electronic and optical properties of atomically thin TMD with an atomic-scale precision. Monolayer TMD samples will be designed fabricated in the in the StNano clean room and studied optically (using photoluminescence spectroscopy and time-correlated single photon counting at variable temperature) to fully characterize single quantum emitters. The same samples will then be studied with a low temperature (4K) scanning tunneling microscope (STM) operating under ultra-high vacuum. We will investigate the samples' surfaces at the smallest possible scale and determine their electronic structure. At the same time, the STM-induced electroluminescence [4] of TMDs will be thoroughly studied, with the aim to provide new insights into the excitonic and optoelectronic properties of TMDs. **Our long term objective is to demonstrate electrically driven single photon sources and develop the field of quantum optoelectronics. This PhD project will launch collaboration between two IPCMS teams working on STM and on two-dimensional materials, respectively.**

References:

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