Activating and controlling the luminescence of two-dimensional materials using tunnelling electrons

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Abstract

A scanning tunneling microscope (STM) is used to electrically activate the luminescence of two-dimensional (2D) materials within a nanoscale tunnel junction, in order to spatially resolve the variations of the excitation quantum efficiency on the nanometer scale. An optical microscope and spectrometer is used to spatially, angularly, and spectrally resolve the emitted light, in order to investigate the emission processes and identify the involved excitonic species (see Fig. 1a-c). In this way, we demonstrate the STM-induced generation of neutral and charged excitons in monolayer transition metal dichalcogenides ($MoSe_2$ and WS_2) [1,2]. Moreover, we show that the tip and tunneling current of an STM can also be used to control the quantum yields of photoluminescence in 2D semiconductors [3] (see Fig. 1d,e). These results open new avenues to probe the interactions between excitons and charge carriers in 2D semiconductors at the nanoscale, interactions that play a key role in the performance of optoelectronic nanodevices based on these materials.

References

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Figures

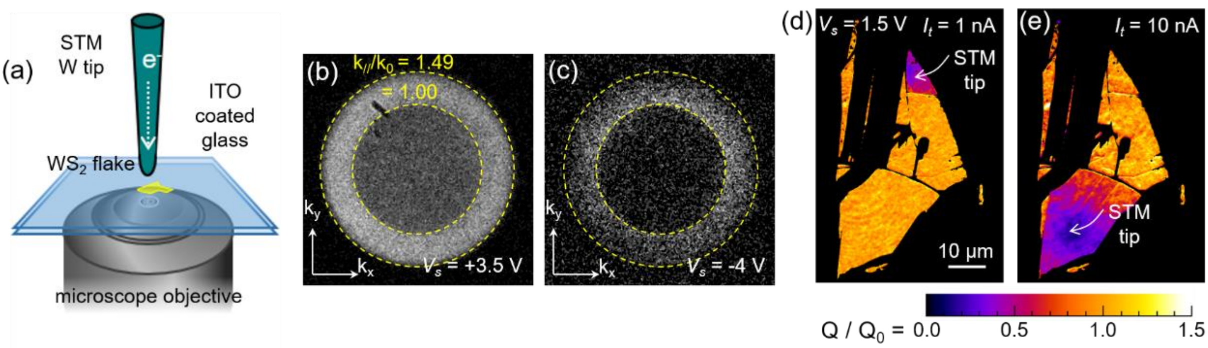

Figure 1: (a) Schematics of the experiment, showing the STM tip and the objective of the optical microscope. (b,c) Angular distribution of the STM-induced luminescence of monolayer WS_2 at positive and negative sample bias, respectively [2]. (d,e) False-color optical microscopy images showing the STM-controlled modification of the quantum yield of photoluminescence (Q) of monolayer WS_2 [3]