High Performance Optical System for a Scanning Tunneling Microscope

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Several processes in a Scanning Tunneling Microscope (STM) can induce light emission from the sample. Among them, some has already been extensively reported on literature, such as emission by plasmonic nanoparticles, direct gap semiconductors and color centers[1, 2]. In this project, we propose to adapt an ultra-high vacuum, low-temperature STM to receive a high-efficiency optical system using a high numerical aperture mirror positioned by a 3-axis piezo nanomanipulator. Numerical simulations predict the light collection efficiency above 70% of the hemisphere. This apparatus applies patented solutions and aims to solve specific problems in the LT-STM environment[3, 4]. Lastly, a software is being developed to integrate and synchronize the whole process. The software will allow us to acquire luminescence maps (hyper-spectral images) simultaneously to the default STM measurements, similarly to cathodoluminescence in a Scanning Transmission Electron Microscopy (CL-STEM)[5]. When fully operational, we plan to apply the LT-UHV-STM with our light collection setup to study nano-structured materials, such as $WSe_2$. Also, we intend to design a photoluminescence setup which will be useful to find specific regions of the sample (using confocal measurements) and to aid us to derive conclusions about the luminescence maps. Finally, this project opens a possibility to implement other surface techniques, such as tip-enhanced Raman Spectroscopy (TERS).