

## Integration of optical components in the light capturing system attached to a LT-UHV-STM

Lucas S. Palhares\*, Yves Auad, Luiz F. Zagonel.

### Abstract

As this project strives to incorporate a functional and efficient method of collecting light emitted by the sample, to a Low Temperature, Ultra-High Vacuum Scanning Tunneling Microscope; the student's role was to properly set up an optical system that ensures light emitted by the sample is collected, via setting up an optical table bolted on the STM vacuum chamber. On top of this table lies an optical system, which main importance is to manipulate the light sample so that all light collected by a mirror be directed to an optic fiber. In this scenario, probing tip-mirror and mirror-fiber alignment is key to ensure optimum light intensity received by the collector that will send the light signal into a light spectrometer.

### Key words:

STM, SPM, Luminescence Mapping.

### Introduction

The usage of STM (Scanning Tunneling Microscopy) as a tool for imaging and manipulation of nanostructures has been a classic since it's first appearance in 1982 by G. Binnig and H. Horher. Our group's initiative aims to attach a device for collecting light emitted by stimulation of the electronic structure of the sample. This phenomenon is caused by the operational method of the STM's probing system in which electrons flow from the tip to the sample (or the reverse).

This light is collected via a patented efficiency system that uses high numerical aperture mirror, and redirected to an optical fiber. To achieve such a configuration, an optical table along with it's components was designed by the student. The project involves the usage of optical parts such as fibers, lens, holders, and so on.

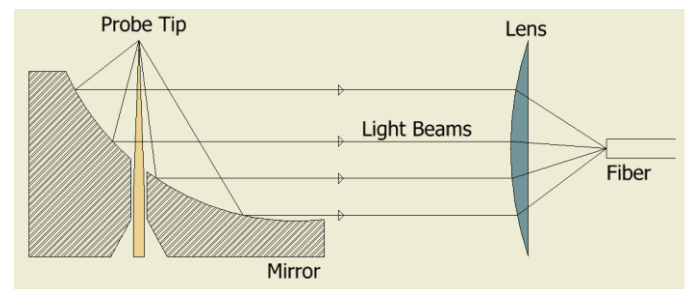
Another problem arises when we look at the geometrical construction of the system: the collecting mirror sits with the tip of the probe at it's focus, and the probe's body placed piercing the mirror through a 1mm diameter hole. It was the student's role to set up a system of cameras that are used for aligning this probe-mirror system.

### Results and Discussion

When addressing the geometrical constitution of our prototype, our first task was to set the position of the mirror. The mirror has a concave shape, so that when the tip of the probe lies at it's focus, the light reflected by the mirror will be redirected in a collimated configuration out of the machine. The idea to achieve such placement was to use a set of two cameras, placed inside re-entrant view windows that are separated by wide angle, to have a 2D+ view of the 1mm-diameter hole so that we can align the mirror-probe position using the mechanical system that moves the mirror.

With our tip in it's optimal location, that is with the probing tip at it's focus, we address the collection of light redirected from the mirror. The vacuum chamber extends to proximally 40cm until the glass shield of the side tube, so that the optic table sits fairly far from the beam's origin, the mirror. The light arrives from the mirror and passes through some lenses. The lenses are mounted on 5 degree-of-freedom holders connected and lead to a fiber at the focus. This means that if the system is properly aligned, the lens will concentrate all light at the entrance of the fiber that will conduct the signal to a CCD camera

or spectroscope for spectral analysis. A schematic model is present at Figure 1:



**Image 1.** A qualitative model containing the mirror-tip system redirecting the luminescent signal to a lens, concentrating the intensity on the fiber's entrance.

But proper alignment is a major objective, for it directly dictates the efficiency in signal collection. To guarantee it, the group is studying alternatives, but at this point we think of using a photoluminescent material in the sample holder that will serve as reference is the best option.

### Conclusions

The strategies concerning the build are taken and the components of the LT-UHV-STM are arriving and soon we will start to assemble the machine.

### Acknowledgement

We thank the funding of CNPQ and FAPESP, projects 2014/23399-9 and 2012/10127-5.

Flexible cathodoluminescence detection system and a microscope employing such a system. Kociak, Mathieu; et al. 2011, France, Registry Number: WO2011/148072 A1, file date: 29/04/2011. Registration Institution: WIPO.

Adjustable cathodoluminescence detection system and a microscope employing such a system. Kociak, Mathieu; et al. 2011, France, Registry Number: WO 2011/148073, file date: 29/04/2011. Registration Institution: WIPO.