Collecting Photons From an STM Microscope

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Abstract

We modify a Tunnel Effect Microscope (STM) with the purpose of analyzing the local production of photons in the electrostatic junction during the image taking process. The novelty of this project compared to previous studies is that it is intended to be developed from the beginning as part of a global research that covers other techniques of Scanning Probe Microscopy (SPM), incorporating all the elements in the same experimental configuration. The starting point is the appropriate simulation and optimization of the creation and detection of light using the Ray Optics Module of COMSOL Multiphysics®, adapting ideas from the models luneburg_lens_go and light_pipe in the Application Libraries. Due to the spatial constraints of the existing setup it is necessary to consider different options of the optical system and make parametric sweeps of several geometric variables and specifications of the parts and materiales to be used. To properly represent the photonics assemble, it has been essential to use the CAD Import Module, as well as the Material Library of COMSOL. The first results indicate the need to use a ball lens in front of a Multimode Fiber Optic Patch Cable to concentrate and transport the photons to the outside of the experimental chamber, as shown in Figure 1.
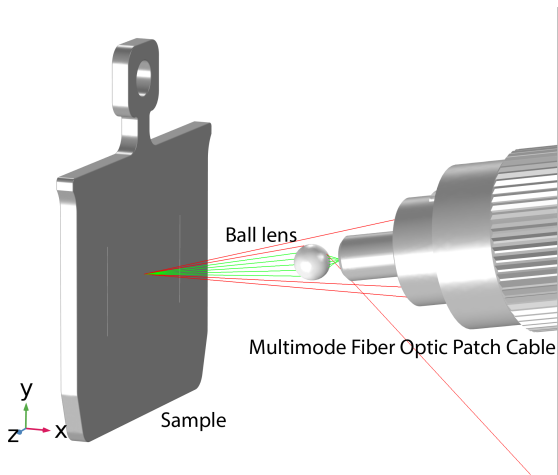
Figures used in the abstract

Figure 1: Simulation of the production, collection and tranport of light in an STM experiment. On the left side is the sample, in the center a small ball lens to concentrate the photons and on the right a fiber optic cable connected to a counter on the outside. For reasons of illustration the tip used to produce the photons via STM mechanism is not shown, and only a few photons can be seen, in green those that are effectively captured and in red those that are lost.