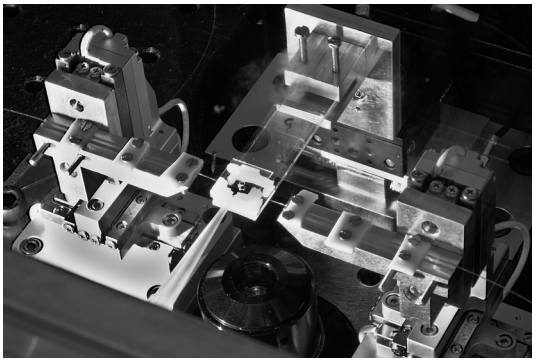
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2020-2021

Development of a Fibered Photonic Force Microscope

General Scope: Since their introduction in 1986, optical tweezers become a standard tool for non-invasive manipulation in microbiology, chemistry, and solid state physics. The importance of this device was underlined by the attribution of the Nobel Prize 2018 to Athur Ashkin, the "Inventor" of the optical tweezers. One less known application of optical tweezers is the Photonic Force Microscope (PhFM). This device allows to measure a surface topology with sub-micron resolution by measuring the shift of a trapped object during scanning over the surface. Its principle is quite similar to that of an Atomic Force Microscope (AFM). In contrast to the AFM, the very small magnitude of the optical forces allows us, however, to characterize very soft samples, thus us biological cells.



Optical Tweezers setup developed at Institut Néel.

In this context we are developing an optical fiber based Photonic Force Microscope. This original approach allows us to overcome one of the major limitations of the actually developed PhFM, i.e. the optical aberrations due to trapping laser beam scattering by the studied sample. This effect alters the trapping properties/ efficiency and interferes with the trapped particle position measurement. In a fiber based PhFM, the trapping laser beam does not transmit through the sample. Moreover, the particle position can be precisely measured by means of the back-reflection of the trapping laser by the trapped particle, which automatically will be coupled into the optical fiber.

Research topic and facilities available: In a first step the student will characterize the optical trapping of micro- and nano-spheres using an original nano-structured optical fiber, allowing us to trap with one single fiber. Special concern will be given to the back-scattered signal which will allow to measure the forces impinging on the trapped particles. In a second step, the student will study trapping of original nano-structured particles. The cylindrical particles with an sharp point at one side allows to significantly increase the lateral resolution of the PhFM. It is intended that at the end of the training first results with "real" samples are obtained. During the training, the student will participate in the optimization of to existing optical tweezers setup for the specific requirements of the future PhFM.

Possible collaboration and networking: This work is part of an ongoing collaboration with the University Stuttgart, Germany and a starting collaboration with University Montpelier.

Possible extension as a PhD: Yes

Required skills: Knowledge in optics/ photonics including integrated optics, fiber optics and optical trapping. The student should also have skills in optics experiments and basic knowledge in LabView-programming would be useful.

Starting date: free, as a function of the students program.

Contact:
Name: Jochen Fick
Institut Néel - CNRS
Phone: 04 76 88 10 86
e-mail: jochen.fick@neel.cnrs.fr
Web : http://perso.neel.cnrs.fr/jochen.fick/