Master / PhD Thesis Project

Analysis and control of bacteria by optical microcavity

Radiation pressure is the force exerted by light when it meets or passes through an object. This force, however small, can be used to move or manipulate objects of micrometric size, like miniature forceps. Generally implemented through a microscope, it is called optical tweezing.

The laboratory has a long experience in the study of photonic crystal microcavities. It has been demonstrated that optical microcavities fabricated on SOI (Silicon On Insulator) substrates allow to realize an extremely efficient confinement of the electromagnetic field, both from the spectral and spatial point of view. The identification and quantification of the optical forces (radiation pressure and gradient) generated by these microcavities has been obtained by observing the movement of micrometric particles placed in solution near the structures. It has been demonstrated that these optofluidic systems allow the identification of a bacterium thanks to its optical signature. This optical signature (variation of the transmitted signal) is characteristic of the morphology and the metabolism of the bacteria. We have taken an additional step by succeeding in determining the state of a bacterium through its interaction with light within the trap. In parallel to these studies, the laboratory has developed a wide field lens-free imaging technique that allows to test the sensitivity of bacterial strains to selected phages (bacteria killing viruses).

In the framework of this master subject, we propose to correlate the results obtained with optical tweezers and those obtained with lens-free imaging. Two types of experiments are envisaged on bacteria subjected to an antibiotic or to bacteriophages. These measurements will be performed on optical tweezers in liquid medium and in lens-free imaging on Petri dish. The objective of this internship is to show the synergy and the correlation between these two types of measurements carried out on a single bacterium (optical tweezers) and on colonies (lensless imaging). The work will be conducted in collaboration with teams specialized in life and health technologies.

This innovative approach will allow to be much faster on bacterial identification and bacterial/phage interaction and could thus contribute to fight against the rising problem of bacterial antibioresistance.
The student should have knowledge in optic and semiconductor physics. An interest in microbiology and life sciences is also highly desirable.

French Commission for Atomic Energy and Alternative Energies
Interdisciplinary Research Institute of Grenoble
Quantum Photonics, Electronics and Engineering Laboratory
17 av. des Martyrs – 38054 Grenoble cedex 9 – France

Recent publications

M.Tardif, E.Picard. et al. On chip Optical Nano tweezers for culture-less fast bacterial viability assessment
Small Volume 18, Issue 4 (2021)

P.Perlemoine, P.Marcoux et al. Phage susceptibility testing and infectious titer determination through wide-field lensless monitoring of phage plaque growth
Plos one (2021)

R. Therisod, M. Tardif. et al. Gram-type differentiation of bacteria with 2D hollow photonic crystal cavities. Appl. Phys. Lett. 113, 111101 (2018)

Tardif, M. et al. Single-cell bacterium identification with a SOI optical microcavity. Appl. Phys. Lett. 133510, (2016).

Contact : Emmanuel Picard – emmanuel.picard@cea.fr

APPLY NOW!

To apply for this position, send your application (including CV) by e-mail to: emmanuel.picard@cea.fr

Commissariat à l'Energie Atomique et aux Energies Alternatives
Institute de la Recherche Interdisciplinaire de Grenoble
17 av. des Martyrs – 38054 Grenoble cedex 9 – France
eva.monroy@cea.fr – Tél : +33.438.78.90.68 – Fax : +33.438.78.51.53