Bacteria analysis and control by optical microcavity

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PhD may follow: Yes

Summary :

Silicon nanophotonic structures can strongly focus light. This results in a very intense electromagnetic field capable of attracting and trapping a bacterium. The latter is then identified by analyzing the fluctuations of the light intensity transmitted by the optical structure. This device still in the development phase has made it possible to distinguish three types of bacteria in a few seconds. This internship is part of the continuity of this study, where we want to study, not only other bacteria, but also the behavior of these bacteria according to external agents (life and death of the cell, effect of an antibiotic effect of temperature).

Full description :

Radiation pressure is the force exerted by the light when it meets or crosses an object. This small force can move or manipulate, in the manner of a mini clamp, objects of micrometric size. 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 manufactured on Silicon On Insulator (SOI) substrate make it possible to achieve extremely efficient confinement of the electromagnetic field, both from the spectral and spatial point of view. The detection and quantification of the optical forces (radiation pressure and gradient) generated by these microcavities was obtained by observing the movement of micrometric particles placed in solution nearby the structures. It has thus been demonstrated that these optofluidic systems allow the trapping, assembly, manipulation and sorting of micro-nano objects in suspension. We went one step further by successfully identifying a bacterium trapped through its optical signature.

As part of this master's subject, we plan to continue these studies by evaluating the potential of these optofluidic technologies in the field of cell biology. A first step will be to evolve the components to an integrated system able to maintain cell viability and compatible with the constraints of spectroscopic measurements. The final objective of this internship will be to propose an optofluidic silicon system allowing to analyze and / or dynamically control the response of a cell to external agent (antibiotic, heat, food). The work will be conducted in collaboration with teams specialized in of life and health technologies.

Recent publications:

R. Therisod, M. Tardif. et al. â€œGram-type differentiation of bacteria with 2D hollow photonic crystal cavitiesâ€•, Appl. Phys. Lett. 113, 111101 (2018)

Tardif, M. et al. â€œSingle-cell bacterium identification with a SOI optical microcavityâ€•, Appl. Phys. Lett. 133510, (2016).