

Advanced microsystems to study intracellular pattern formation

Proposers

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Introduction

Most living systems, ranging from animal flocks, self-motile microorganisms to the cytoskeleton rely on self-organization processes to perform their own specific function. Inside the cell, order and pattern formation may be transient and localized as many reactions within a cell occur in specialized locations, where the basic tenets of biochemical kinetics may break down. Developing microsystems to observe and control localization, geometric and temporal regulation of complex artificial biochemical networks as well as of living cells will allow us to elucidate principles of active pattern formation.

Partner 1

The Biomolecular Self-Organization group at ITQB-NOVA is an expert in biophysics of active bio-matter, cellular biochemistry and optical system development.

Partner 2

The Ultrafast Bio- and Nanophotonics group at INL is expert in the development of advanced live cell bioimaging techniques, surface functionalization for super resolution imaging and laser based 3D scaffold fabrication.

Project outline/goal

The major goal is to obtain a sound physical understanding of cellular self-organization, by successively increasing the complexity of the experimental system in a bottom up approach. Some of the goals are: i) to implement a recent super resolution microscopy technique based on near field interactions to investigate the role of geometry (by PDMS microfluidics) and spatial localization (by surface functionalization) of components in a reconstituted cellular system; ii) to develop further the technique for 3D imaging in order to monitor cellular force sensing and signaling in live cell studies of; iii) to design and develop advanced microsystems to combine geometry, spatial location and volume to mimic cellular structures to elucidate the complex interplay of signal transduction and active pattern formation.

Student profile

Profile sought: preference, but not limited, to students with a background in Engineering Physics, Biomedical, Biochemistry or Biological Engineering with an interest in exploring complex biochemical and advanced microsystems to answer fundamental questions. Experience in Micro and Nanofabrication, optics and/or in protein biochemistry would be helpful.