Development of Mueller Matrix Imaging Microscope with application to real time observation of cells in ambient conditions

Background Context

A Mueller matrix is the most complete description of the way the polarized light interacts with media. Exploring imaging, spectroscopy and Mueller Matrix Ellipsometry thus combines simultaneously the three principal characteristics of light. Exploring the change in amplitude and phase of the polarization state of light through strongly anisotropic surfaces and more generally specially patterned metasurfaces, and the following response to environmental changes, is still in its infancy. This project is a continuation of an ongoing project related to the development of a Mueller Matrix Imaging Microscope. The microscope system is still in a development phase, and previous applications have been related to thin sections of bio-tissue, ranging from cartilage [1], fibres [2] and plaques.

[1] P. G. Ellingsen et al. (2014). "Mueller matrix three-dimensional directional imaging of collagen fibers." Journal of Biomedical Optics **19**.
[2] P. G. Ellingsen et al. (2011). "Quantitative characterization of articular cartilage using Mueller matrix imaging and multiphoton microscopy." Journal of Biomedical Optics **16**.

Student Project Description

In the current project the student will work on developing and applying the Mueller Matrix microscope with application to imaging of low contrast species such as cells moving along a surface. The recently developed concept of exploring an anisotropic plasmonic filter to enhance the sensitivity to objects on the surface will be explored. The microscope will also be used in the characterization of metasurfaces produced in parallel projects. As such, unique features of the Mueller Matrix such as phase change sensitivity of cross-polarization will be explored.

Background Skills

The project demands knowledge of Matlab and Labview and preferably also knowledge of Python/c++, a good portion of linear algebra, and is a good opportunity to develop instrumentation skills, hands on experience with optics and concepts from bio-physics and nanostructured surfaces.

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Possible co-supervisors for second phase of project: P. Sikorski and PhD students.