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Optical Tweezers Towards Single-Cell Analysis

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Optical Tweezers have become a popular tool for manipulating micron diameter particles with minimal influence on the properties of said particles. By using a single laser and a high numerical aperture lens, these particles can easily be confined and moved for the researcher's purpose. Such manipulation allows for the measurement of piconewton forces, which makes it possible to measure the molecular forces inside biological cells and to characterise fluid dynamic systems in terms of flow rate and shear forces. These capabilities have led to significant contributions to the fields of biochemistry and biomedicine. Another groundbreaking tool for studies in these fields are microfluidic "lab-on-a-chip" devices.

By combining the manipulation capabilities of Optical Tweezers with a microfluidic device's ability to control the external environment of cell, the response of the cell to external stimuli can be measured. This includes monitoring drug uptake as a function concentration, as well as the expression of various biomolecules on a single-cellular level. The microfluidic device allows for maximal control and change of the extracellular environment while the optical tweezers create an easy method of moving single cells to these controlled environments. This process can be parallelised which can lead to the high throughput analysis of therapeutic drugs. This integrated system will also have the benefit of providing a sterile environment to do biochemical studies in but also ensures minimal influence from unwanted external factors.

In this talk, we will discuss the principle behind single-beam Optical Tweezers and the construction of such a setup and under what conditions a stable trapping is achieved. This setup includes custom fluorescence- and Raman spectroscopy modules to the setup as well as a force calibration module which allow for the characterization of the trap. The system can be further expanded with the inclusion of a spatial light modulator to speed up analysis and increase throughput. Furthermore, we look at the basic operating principle of microfluidic devices and different designs of these devices. We then look towards biological analysis of yeast strain saccharomyces cerevisiae, known more commonly as brewer's yeast, and the conditions which allow for such cells to be trapped. Initial proof of principle measurement will be shown. .

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

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