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Single Cell Mass Measurement with Microcantilever Biosensor

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Extended Abstract

The mass is one of the basic biophysical parameters describing the properties of biological systems. It is inherently connected to many important intracellular biophysical processes like protein expression or cell division [1]. Only few experimental methods can determine mass of a single cell, however most of them obtain their results indirectly by determining the cell volume and approximating the density of the cell. Microcantilever-based biosensor method allows us to determine the mass of an adherent cell in a direct and non-destructive way. Additionally, the measurement is label–free - it does not require any external markers or fluorescent labels as compared to other methods. In this work, we determined the average value of the mass of single cell of brewer yeast *Saccharomyces cerevisiae* using the dynamic mode of 8-cantilever arrays CLA500-070-08V Cantisens system (Concentris- Switzerland).

Microcantilever-based sensor uses a laser based optical system to determine the oscillation frequency or bending amplitude of microcantilever. Laser light illuminates the free tip of the cantilever and Position Sensitive Detector (PSD) determines the position of reflected light [2]. Then the PSD signal is used to determine the bending amplitude or resonance frequency of the cantilever excited by the piezoelectric element. The general idea of cantilever-based sensors was born before 1970, but the huge potential of this method was explored only in last few decades, when the sensor miniaturization technology was fully developed. Microcantilever-based methods were then expanded to other research areas like biology, biotechnology, chemistry and physics. They were employed to measure with high precision and sensitivity various material and environmental parameters like viscosity, temperature, density, flow velocity or reaction energy.

Yeast cells are eukaryotic microorganisms classified as members of the fungus kingdom. Yeasts cells typically measure several micrometres in diameter. We chose them because *S. cerevisiae* are simple eukaryotic cells, serving as a model for all eukaryotes. Furthermore, yeast cells are easy to culture and are resistant to environment conditions like dehydration. They also have a simple shape which allowed us to observe and count them using optical and confocal microscopies. The yeast strain used in this study is mainly used in the production of alcohol.

Cell mass determination is based on resonance frequency shift between loaded (with yeast cells attached) and unloaded cantilever [3]. The measurements were performed in the fundamental mode of resonance frequency. We measured the decrease in the value of the resonance frequency related to the increase of cantilever's weight in each measurement. The optical and confocal microscopies were employed to determine the position of each cell on cantilever surface which was crucial for a precise calculation of single cell mass. We determined it to be (47,6± 1,1) pg. The results show that cantilever-based biosensors are a powerful tool which can be used in detection of cellular mass changes, even for single cells, reaching accuracy of single picograms.

References

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