

Development and Trials of a Test Chamber for Ultrasound-assisted Sampling of Living Cells from Solid Surfaces

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Abstract – Various surfaces in biotechnological and food industry, healthcare facilities and other epidemiologically relevant fields are subject to continuous contamination by microorganisms [1]. Regular sampling and adequate cleaning of such surfaces mainly composed of metal, plastic and glass represent the main approach to control the hygiene of medical and food products [2].

The method of recovering microorganisms from different solid surfaces is critical for reliability and objectivity of sampling and microbiological risk assessment. Today, sampling by cotton or rayon swabs is undeservedly considered the “gold standard”. In reality, the swabbing methods suffer from numerous drawbacks. Therefore, efficient, reliable, quick and cheap sampling methods still have to be defined and standardized for better control of microbiological hazardous events, especially for porous and irregular materials.

A project called BacHarvester was launched to provide a new technique that will help in collecting bacteria attached to any solid surface and collect them while keeping them alive. Our working group has focused on designing a flow chamber supposed to serve as a standardized testing setup for this project. The aims were first to design and construct, and later to test an experimental chamber for detachment of erythrocytes and yeast cells using different ultrasound intensities.

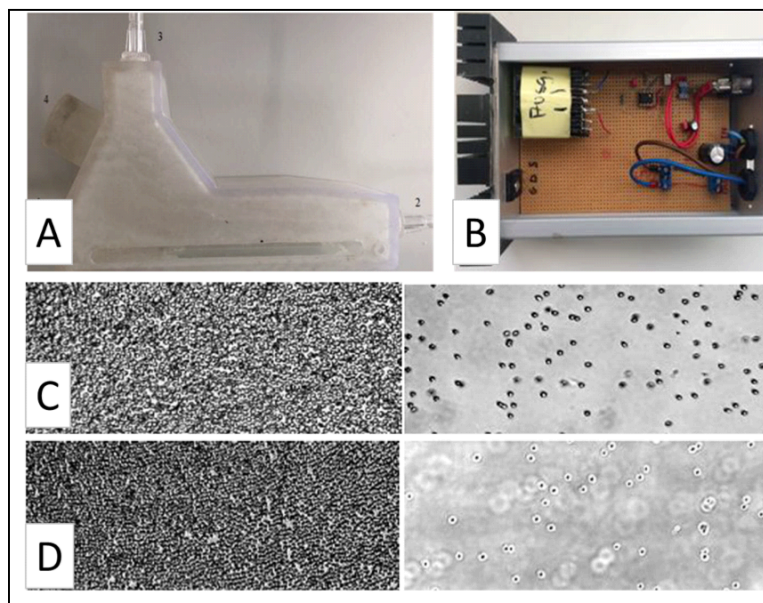


Fig. 1: A: The 3D-printed test chamber: 1) inflow; 2) outflow; 3) de-airing tube; 4) ultrasonic head fixation. The cells were placed on a microslide and inserted into the chamber using a slot near the bottom. B: The driver board of the ultrasound transducer. C: Erythrocytes attached to the microslide before (left) and after ultrasound exposure (3 minutes long). D: Yeast cells (*Saccharomyces cerevisiae*) attached to the microslide before (left) and after ultrasound exposure (3 minutes long).

A new flow chamber for the tests was designed using the Autodesk® Inventor® 3D CAD software and printed mainly with a 3D printing process (Fig. 1, A). The material used was synthetic resin. This material selection allows for a more cost-effective production process. The ultrasound transducer used in this project had a resonance frequency of 40 kHz, maximal applied voltage of 160Vp-p and the maximal output of 3 W. To get the optimal cavitation and the optimal detachment results, a kpus-40fd-14tr-k766 ultrasound sensor mounted into an aluminum housing was used. This ultrasound transducer had a sound pressure level of 103 dB in air according to calibration parameters.

The driver board (Fig. 1, B) was used as a function generator is specialized for ultrasonic generators, usually for ultrasonic levitation experiments. It transformed electrical input to a signal for the ultrasound transducer to accept. One of the advantages of this kind of circuits is its high-level amplification.

The filling phase took around 15 minutes, and along with that, blood cells were observed under the microscope. No appreciable detachment of the blood cells was detected due to the flow. Afterwards, the ultrasound waves were applied to the sample of the blood cells. The observed detachment of the cells (Fig.1, C and D) mainly was due to two effects. The first is the cavitation, which usually induces a powerful shock that can detach cells from each other. The second is a phenomenon called microstreaming, which in turn, may also have considerable effect on this kind of detachment [3, 4].

References

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