An innovative method for selecting optimal working conditions in acoustophoretic devices

Moving cells with sound? It is actually possible! This phenomenon is called "Acoustophoresis". How do you set the sound? Is it ok to use songs by Bob Dylan? We are sorry to say no, but we have developed an innovative method to identify the optimal working conditions for acoustophoretic devices (devices that exploit "Acoustophoresis").

"Acoustophoresis" is a technique that induces the motion of particles suspended in a solution by sound. The solution flows inside a small channel that has dimensions in the order of micrometers, exactly like a human hair, with a thickness that varies between 18 and 180 µm. Moreover, the microchannel is dug in a bigger structure called "microchip" and this microchip, in turn, is glued to a piezoelectric transducer (piezo). A piezo is a component that generates oscillations and therefore sound waves. Since the piezo is glued to the microchip, the piezo causes the microchip to oscillate and sound waves will travel in it. In order to be able to move particles present in a solution, the microchannel must be in specific conditions, known as resonance conditions. In resonance conditions, a lot of energy is present in the microchannel and forces, called acoustic radiation forces, are able to move particles in specific locations depending on their physical properties. In particular, when particles are moved to the center of the channel, we will refer to it as particles focusing. Particles can therefore be manipulated and, if they have different properties, can be also separated (Figure 1). "Acoustophoresis" has been used in interesting applications such as the separation of lipid particles from red blood cells after open-heart surgeries, and the detection of circulating tumor cells.

Resonance conditions are necessary to manipulate particles in acoustophoretic devices. Nowadays, what it is usually done to determine when the microchannel is in resonance conditions is to observe when the particles focus, using a microscope. This procedure is time consuming and operator dependent. In our project, we wanted to avoid the use of the microscope and to use other tools to identify the resonance of the microchannel. In particular, we used impedance measurements. The impedance is an electrical characteristic of a system and it is a measure of the opposition that a system presents to a current when a voltage is applied. It can be easily measured using a machine called impedance analyser. Using these measurements, we found that it is possible to identify when the channel is in resonance conditions avoiding the use of time consuming visual inspections. This result is great, since it opens the route to a fast and automatic tuning of acoustophoretic devices.

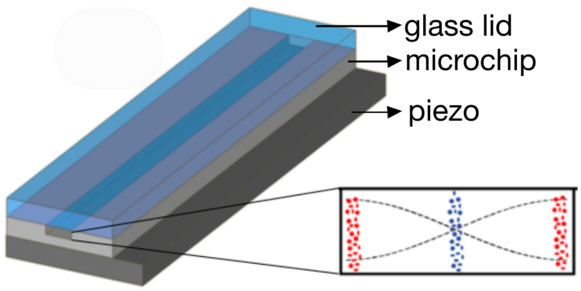

Figure 1: A typical acoustophoretic device: a microchannel is dug in the "microchip" which, in turn, is covered by a glass lid, and a piezoelectric transducer is glued underneath the microchip. A zoom in shows what happens when a particles suspension is infused into the microchannel in resonance conditions: particles with different properties are separated.