Sample pretretment in microsystems - DTU Orbit (09/11/2017)

Sample pretretment in microsystems: µFACS, dielectrophoresis and electrothermal induced fluid flow

When a sample, e.g. from a patient, is processed using conventional methods, the sample must be transported to the laboratory where it is analyzed, after which the results is sent back. By integrating the separate steps of the analysis in a micro total analysis system (µTAS), results can be obtained fast and better. Preferably with all the processes from sample to signal moved to the bedside of the patient. Of course there is still much to learn and study in the process of miniaturization. DNA analysis is one process subject to integration. There are roughly three steps in a DNA analysis: Sample preparation → DNA amplification → DNA analysis. The overall goal of the project is integration of as many as possible of these steps. This thesis covers mainly pretreatment in a microchip.

Some methods for sample pretreatment have been tested. Most conventional is fluorescence activated cell sort (FACS). In µFACS the cells are treated chemically so those with specific properties become fluorescent, cells are then sorted and collected based on their fluorescence. A µFACS device has been tested and characterized. When moving down in size, one is also moving into a regime where phenomenons that only have a tiny effect in the large scale gains strength and — if utilized right — usefulness. Another method, only suitable in microsystems, is the influence electric fields have on cells. A field will impose a force when applied on a cell, this force will result in movement of the cell, an effect named dielectrophoresis (DEP). As DEP grows stronger and more manageable when the electrodes are scaled down, it is useable for cell manipulation in a microsystem. The strength and direction of the DEP force depends on the properties of both cell and fluid at the chosen frequency, together with the geometry of the electrodes. Different cells have different dielectric properties. This phenomenon is used to sort dead/live cells and washing cells as pretreatment for DNA analysis. However, where a large system is easy to handle, measuring with conventional methods in a microsystem might just as easily disrupt what is being measured. To understand the observed phenomena, different tools for characterization in a microsystem have been evaluated. These range from particle image Velocimetry (PIV), to simulation of the flow. The fluid flow generated by electrothermal mechanisms in the DEP electrode structure has been simulated. Finally the sample pretreatment using DEP has been assembled with a DNA analysis chamber, and the resulting microstructure has been examined.

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