



Assignment Lab-on-a-chip for forensics

Assignment B (BSc): Detection of nucleic acids – Analytical Chemistry

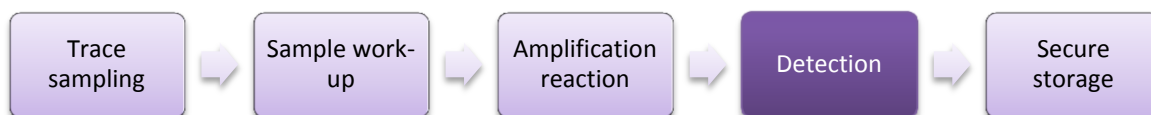
Introduction:

The number and variety of forensic traces found at a crime scene is enormous. The term forensic science is therefore very broad and can be divided in several expertise areas, such as DNA profiling, blood spatter analysis, explosives and illicit drugs. It is a clear desire of forensic investigators that analyses should be simple, fast, robust, cheap and have high sensitivity and selectivity. Devices with these specifications can be used directly at the crime scene and are especially useful as they can provide immediate information to the police investigators. Most ideal would be a mobile forensic lab for collecting, screening and analysis of the evidence. So-called 'lab-on-a-chip' (LOC) systems can speed up the analysis, are compact, can easily be integrated, limit the risk of contamination and can be used by people who are not technically trained.

However, micro-devices for forensic investigation hardly exist [1]. Experts in LOC technology and/or nanotechnology do not have experience and knowledge about forensic science. On the other hand, forensic experts are in general not familiar with LOC devices. The two disciplines have not yet been combined often in order to obtain an LOC device for forensic research. Combining both disciplines is a goal of this assignment.

Theory:

Several advantages of lab-on-a-chip devices are the fast analysis time, high throughput, minimal amount of analyte material needed, less waste and compactness [2]. Exactly these benefits are the desires of forensic scientists. Other advantages of LOC are limitation of (cross-) contamination, improved chain of custody and possibility of direct analysis at the crime scene, which are the most important issues within forensic science. Obtaining an on-chip DNA-profile is complex as DNA extraction, PCR amplification and STR fragment separation have to be integrated on chip, as can be seen in the figure below [3,4]. Moreover, the 12-72 hour analysis of conventional techniques has to be beaten [4,5]. Fast results are required as a suspect can be held in custody for only 6 hours [5]. For the analysis of human biological samples micro-devices are developed for extraction, purification, amplification, separation and detection.



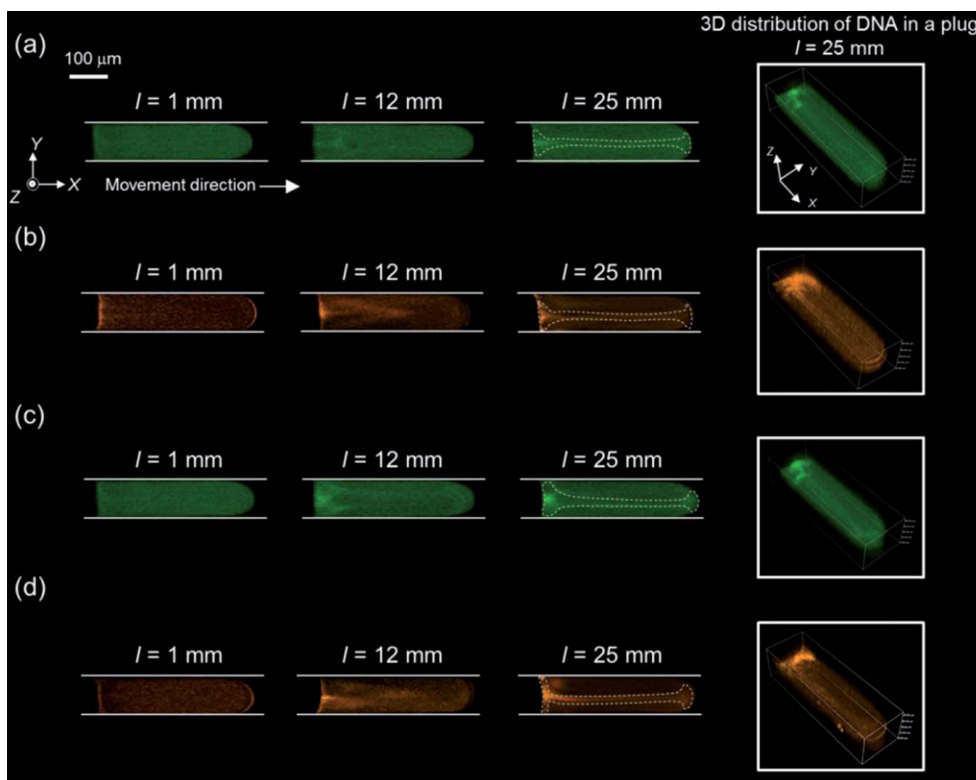


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An important part of DNA-analysis is the detection of the nucleic acids. The presence of a sufficient amount of DNA means that the amplification reaction was carried out successfully.

A literature study has to be carried out prior to design chips for forensic DNA-analysis.

- Literature study (~ 2-3 weeks)
 - **Microfluidics:** Get an impression of the possibilities of the use of microfluidics/lab-on-a-chip technology for forensics. Give a short overview of forensic applications (e.g. drug detection, DNA-analysis or fingerprints) of these devices. Which materials (e.g. glass or silicon) can be used for (forensic) chips?
 - **Detection of nucleic acids:** Which methods can be used to detect the presence of nucleic acids in a sample (e.g. fluorescent probes or SYBR green)[6,7]? Which of these methods can be used on chip and from what material is such a chip made off (e.g. glass or PDMS). Can these methods also be applied on droplet based microfluidic systems?



From reference number 6



Chip fabrication will be carried out in the cleanroom with micromachining techniques including the set-up development with the microscope and fluidic control.

- Chip experiments and experimental setup (~ 5-6 weeks)
 - **Setup for nucleic acid detection:** Elaborate the most promising detection method to confirm the presence of DNA. The method can be based on fluorescence (with a inverted confocal microscope) or another method.
 - **Detection of nucleic acids:** Test the setup with existing PDMS chip (or with a new design if necessary). Determine the detection limit and the threshold for the selected method.
 - **Detection of nucleic acids in droplets:** Test the setup with nucleic acids present in droplets within the microfluidic system.
- Finishing of the report and preparations for the final presentation (~ 1-2 weeks)



References

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