Everyday’s Chemistry and Physics

The session *Everyday's Chemistry and Physics* consists of the following two sub-sessions:
- **Forensics**
- **Chemie & Maatschappij Groep** (CMG; Chemistry & Society group of the KNCV)
  [http://www.kncv.nl/chemie-maatschappij-groep.8950.lynk]

**Forensics**

In forensic investigations physical and chemical sciences are used to solve crimes and assist in the conviction of the guilty and the exoneration of the innocent. It can thus be stated that the forensic application of science plays its part in "Everyday's Chemistry and Physics". This is especially true for DNA profiling, the most successful forensic method to date to solve crime. Safety and Justice in any society are aided by state-of-the-art forensic methods to objectively reconstruct (criminal) events. In recent years forensic science has attracted increasing attention in Dutch society, media and academic world. Besides the well-known CSI effect also the new forensic HBO and academic education programs have contributed to the growing interest. Besides the NFI also other laboratories and institutes, like TMFI and Verilabs have entered the "forensic arena" and are offering and developing forensic products and services. In the wake of these developments, a mature forensic science research program is being established in the Netherlands. NWO's Forensic Science program has recently started and also other national and international funding is being acquired for forensic science projects at Dutch universities. The forensic session will illustrate these growing forensic science efforts by giving young Dutch scientists an opportunity to present their work. This work involves both chemistry and physics to develop innovative forensic methodology and tools that can be applied directly at the crime scene.

**Programme**

**Forensics**

- Arian van Asten (Chairman of the Forensics Section of the KNCV) - Introduction of the Forensics session
- Nick Laan (Van der Waals-Zeeman Institute - UvA) - Improving Bloodstain Pattern Analysis: The Impact Dynamics of a Blood Droplet
- Saskia Lambregts (Biomedical Engineering and Physics - AMC) - Autofluorescent Fingermarks
- Brigitte Bruins (MESA+ - UT) - Lab-on-a-chip applications within forensics

Convener: Arian van Asten

**Abstracts**

**Forensics**

Nick Laan1,2, K.G. de Bruin2, D. Bonn1 - Improving Bloodstain Pattern Analysis: The Impact Dynamics of a Blood Droplet

1) van der Waals-Zeeman Institute, University of Amsterdam
2) Netherlands Forensic Institute, Ministry of Security and Justice

We show how the impact velocity of a bloodstain can be determined by means of general fluid dynamic principles and how this can be used to improve methodology for the region of origin determination on crime scenes.
To determine the region of origin of a bloodstain pattern, usually the stringing method is used, either with real or virtual strings. The stringing method is based on the assumption that the flight path is a straight
However, ballistic objects like blood droplets are not projected through the air in a straight line but rather follow a curved trajectory due to gravity and air resistance, which causes an error in the determined region of origin. In addition, only upward directed bloodstains can be used for a reliable region of origin estimation.

Four parameters are required to unambiguously describe the path of a blood drop which accounts for gravity and air resistance: 1) position 2) impact angle 3) volume and 4) impact velocity. We focus on how the impact velocity can be determined from a dried stain. Our laboratory experiments show how the impact velocity of a droplet is related to bloodstain size and volume. We measured this for various surfaces of different surface roughness and wettability.

Saskia Lambrechts¹, A. van Dam¹, T. Sijen², M.C.G. Aalders¹ - Autofluorescent Fingermarks
1) University of Amsterdam, Biomedical Engineering and Physics, Academic Medical Center,
2) Netherlands Forensic Institute, Ministry of Security and Justice

Fingermarks are used for the identification of their donor via ridge groove pattern and/or DNA analysis. The property of fingermarks to display fluorescence when excited by UV and/or visible light is useful for their detection [1,2]. It is currently unknown what components are responsible for this autofluorescence [3]. Fingermarks are composed of cells, sebum, sweat and external components such as soap, skin care products and dirt [4,5]. Personal hygiene, temperature, occupation, diet and time of the day are just a few of the many factors that influence the composition of fingermarks. This variability may offer opportunities to profile the fingerprint donor. In this presentation recent findings on the nature of the autofluorescence of fingermarks will be presented, and its potential application for donor profiling and time dating will be discussed.

Micro-devices have become of interest to forensic scientists as these systems can speed up the analysis time, are compact, can easily be integrated, minimise the amount of (analyte) material needed, and can be used by people who are not technically trained. Another advantage is the minimal amount of analyte material needed. Due to sample handling in a sealed microfluidic environment, LOC systems reduce the risk of (cross-)contamination, improve the chain of custody and provide the possibility of direct analysis at the crime scene; all these issues are important within forensic science. The ultimate goal is to develop a so-called "lab-on-a-chip" device that can be used for all the necessary steps from sample preparation till detection.

The aim is to develop a LOC system to screen traces at the crime scene for human genetic material. The device integrates different functions, ranging the first steps in the investigation (securing and processing the sample at the scene of the crime), to an easy-to-read output for the user and secured on-chip storage of the sample for a more detailed analysis in a forensic lab. The focus lays on detection of human DNA in the trace in a presumptive way. To speed up the analysis and improve the limit of detection, amplification is performed in water-in-oil droplets in microchannels; each droplet functions as an independent microreactor. To minimize analysis time isothermal amplification is investigated. Therewith, instead of cooling and heating rates as in conventional PCR, the enzyme reaction rate becomes the limiting factor. To detect minute amounts of DNA, fluorescence is applied.

Droplet microfluidics as well as isothermal amplification of genetic material are upcoming fields of research, which will be combined in LOC-devices for the first time to analyse forensic case samples.