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.lynkx

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.

CMG

The KNCV wants to contribute to a broader debate about socially relevant chemical topics and additionally wants to play an advisory role in industrial and political decisions regarding the chemical profession. The Chemie & Maatschappij Groep (CMG) is an advisory organ (think tank) of the KNCV. On behalf of the KNCV, the CMG probes the opinion of the chemical community on socially relevant topics. The CMG uses various instruments, in particular round table debates, interviews and polls. The findings, together with the arguments and the factual justification, will be communicated (e.g. by presentations and/or reports) by the CMG and KNCV as the expert opinion established in their research.
In 2011-2012 the CMG focuses on subjects as the Materials Scarcity, Synthetic Biology and Energy. The CMG presentation at FYSICA-CHEMIE 2012 will provide the audience the first results of our findings for the subjects Materials Scarcity and Synthetic Biology.

Programme

Forensics

- Arian van Asten (Chairman of the Forensics Section of the KNCV, UvA) - 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

CMG

- Introduction by the chairman of the CMG of the KNCV

- Koop Lammertsma (VU) - Material Scarcity – Endangered Rare Earth Elements and Phosphorus
- Klaas Hellingwerf (UvA) - Synthetic Systems Biology: History, definition and impact
- Roel Bovenberg (DSM, RUG) - Systems and Synthetic Biology from an Industrial perspective

Conveners: Koop Lammertsma (VU and CMG) and Arian van Asten (NFI and UvA)

Abstracts

Forensics

Nick Laan[1,2], K.G. de Bruin[2], D. Bonn[1] - 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 line. 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.

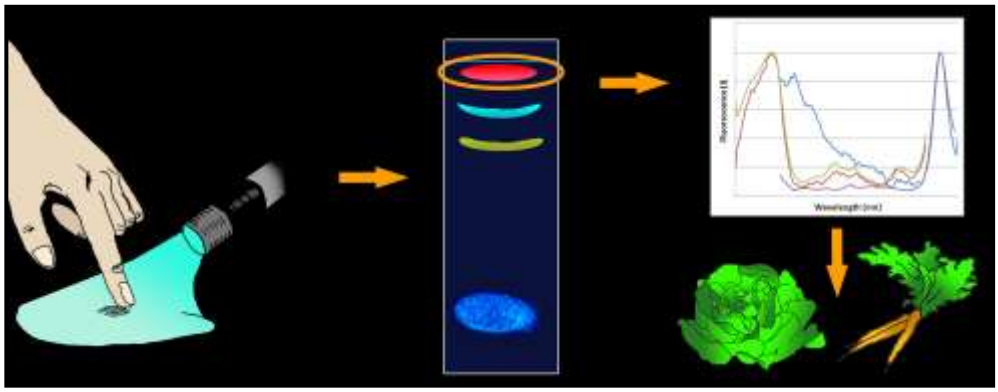
Saskia Lambrechts[1], A. van Dam[1], T. Sijen[2], M.C.G. Aalders[1] - Autofluorescent Fingermarks

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

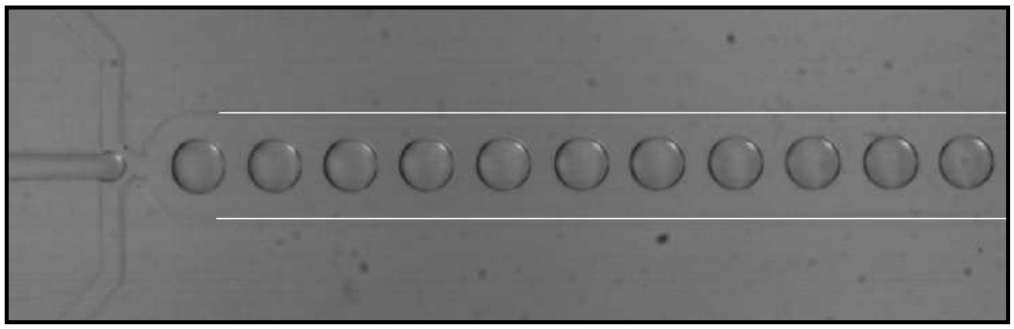
their detection [1,2]. It is currently unknown what components are responsible for this autofluorescence [3]. Fingermarks are composed of cells, sebum, sweat and external components such as soap, skin care products and dirt [4,5]. Personal hygiene, temperature, occupation, diet and time of the day are just a few of the many factors that influence the composition of fingermarks. This variability may offer opportunities to profile the fingermark 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.

[1] M.M. Schulz, F. Wehner, H.-D. Wehner, The use of a tunable light source (Mini-Crimescope MCS-400, SPEX forensics) in dissecting microscopic detection of cryptic epithelial particles, J. Forensic. Sci. 52, 4 (2007) 879-883.
[2] B.E. Dalrymple, J.M. Duff, E.R. Menzel, Inherent fingerprint luminescence – detection by laser., J. Forensic. Sci. 22, 1 (1977) 106-115.
[3] N.E. Jones, L.M. Davies, J.S. Brennan, S.K. Bramble, Separation of visibly-excited fluorescent components in fingerprint residue by thin-layer chromatography, J. Forensic. Sci. 45, 6 (2000) 1286-1293.
[4] R.S. Ramotowski, Composition of Latent Print Residue, in: H.C. Lee and R.E. Gaensslen, (Eds.), Advances in Fingerprint Technology, CRC Press, Boca Raton, 2001, pp. 63–104.
[5] B. Scruton, B.W. Robins, B.H. Blott, The deposition of fingerprint films, J. Phys. D: Appl. Phys.8 (1975) 714-723.



Brigitte B. Bruijns[1], A.D. Kloosterman[2], K.G. de Bruin[2], A.C. van Asten[2] and J.G.E. Gardeniers[1] - Lab-on-a-chip applications within forensics
1) Mesoscale Chemical Systems, Mesa+ Institute for Nanotechnology, University of Twente
2) Netherlands Forensic Institute, Ministry of Security and Justice

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.



CMG

Koop Lammertsma (VU) - Material Scarcity – Endangered Rare Earth Elements and Phosphorus

The rapidly growing global population requires ample natural resources, but the demand-supply chain points to real, perceived, and potential disruptions. Most prominent are the rare earth metals, but also the availability of phosphates has come to the fore.
The availability of rare earth metals is limited due to the geographically restricted number of mines and purification plants. The list of endangered elements is growing fast, with some predicted to become exhausted within decades. The pressure on phosphates illustrates the need for fertilizers to produce food to sustain the world's growing population. With phosphorus being a life element, limitations in its supply will be life threatening. Recycling of rare earth metals and phosphates are processes that have just started and needs far more focus.
Material scarcity is therefore an increasingly important economic and political issue. This presentation aims to give an up-to-date analysis.

Klaas Hellingwerf (UvA) - Synthetic Systems Biology: History, definition and impact

The term synthetic biology can be used to refer to various experimental approaches in the life sciences, of which the two most extreme ones are: (i) Building up a living cell from all the constituent molecules, to (ii) reprogramming the genetic program of a living cell. The latter definition, however, makes it relevant to provide a distinction between biotechnology (or: genetic engineering) and synthetic biology.
Consensus has it that these two notions are distinguished on the basis of the extent of reprogramming: We use genetic engineering if only one, or a few (biochemical) reactions are added to the repertoire of the cell, whereas in synthetic biology entirely new regulatory and/or metabolic networks are added and/or removed.
Synthetic biology is a natural ally of systems biology. Whereas the quantitative analyses of systems biology are key to interpret synthetic biology experiments, the field of synthetic biology provides the tools to test the advanced models for living cells/organisms that emerge in systems biology. It is therefore reasonable to assume that these two specializations will merge into the field of 'synthetic systems biology', a field that will have an enormous impact in the future of the life sciences.

Roel Bovenberg (DSM, RUG) - Systems and Synthetic Biology from an Industrial perspective

The impressive development in analytical and computational capabilities to characterize complex biological systems like cells, tissues and even entire ecosystems on the one hand and the emerging capabilities to design and synthesise new biological functions using genetic instructions on the other hand change the way we do research. It requires a change in mindset and leads to new work processes in the lab and environment where final application will be done. The challenge is to define what knowledge is actually needed to be successful. The presentation will give selected examples of industrial applications based upon systems and synthetic biology approaches.