KIST Europe

Korea Institute of Science and Technology

Annual Report 2010

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Preface - Greetings of the Institute Director

Dear readers,

I am very pleased to present the second annual report of KIST Europe research institute. Again, it covers the most notable events in 2010, along with a number of scientific highlights, an overview of our research outputs and the publications in international scientific journals.

KIST Europe was established as a research institute abroad in 1996. The main objectives of KIST Europe are to contribute to the globalization of Korean R&D activities in the fields of mutual interests and to set up a platform for the promotion of science and technology cooperations between European and Korean partners.

KIST Europe has made a large progress in the research fields including Nanomedicine, Bio-MEMS, Medtronics, Mechatronic sensors and actuators. In addition, KIST Europe has performed many activities to build a cooperation network between Korea and EU. For this purpose, we have managed many seminars and joint workshops on R&D issues so far.

In the meanwhile I have recognized that all our members have done great job and made major contributions to build up this current KIST Europe, under sometimes difficult circumstances. I would like to extend my appreciation to previous directors and all the ex- and current members of KIST Europe for their great effort and devotion. I am extremely proud of all members of KIST Europe for their continued and tireless effort in pursuing our mission.

And I also acknowledge the Korean government and KIST Korea for their continued encouragement and support. I am grateful to the Saarland government and Saarland University for their kind interest and support. I will do my best and devote myself to return these hitherto efforts and supports.

In October 2010 we realised the reorganisation of the research departments. Prof. Dr. Andreas Manz became responsible to enhance our research activities. Together with him, KIST Europe will achieve a breakthrough in our research areas in near future.

Now, KIST Europe have the opportunity to publish our activities thanks to our researchers' efforts. The major goal of the publication of this annual report is to show our current activities and suggest some research ideas to our potential collaborative partners. We really welcome any collaborative idea from EU research organizations or industrial sectors. We are always open to any suggestion on collaboration between EU and Korea. I am sure that such collaboration will also promote the economical relations between Korean and European partners, as well as the advancements in science and technology research.

I hope you enjoy reading this report.

Dr. Kwang Ho Kim
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Greetings of the Head of Research

Prof. Dr. Andreas Manz
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Dear readers,

I am very pleased to present the research activities of KIST Europe during 2010. It has been a "take off" in many ways. At first, a reorganisation took place early in the year, due to the departure of two important members of the research management. Then the added space provided by our second building was freeing up offices in the first building. And finally, a steady and continued influence of research portfolio management starting in October, will leave its marks on current and future research output.

We are all very proud of the wonderful opportunity we got here at KIST Europe, and try to do our best to promote collaborations between Korea and Europe, to establish independent high-quality research in our laboratories, and to get involved in university education.

I would like to acknowledge the generous funding by the Korean government, our host county Saarland, all my co-workers and everybody else involved in or supporting our research.

Contents

KIST Europe - a summary

The Korea Institute of Science and Technology in Europe (KIST Europe) was established in 1996 in Saarbrücken, Germany, as an overseas branch of the KIST in Seoul, Korea.

A decade ago, at a time when the globalization of science and technology was a new concept, the KIST Europe was the first and only Korean government commissioned R&D institute abroad with R&D capability in its own right.

Since then, the KIST Europe has endeavored to build global S&T networks with prominent EU research institutes in the field of basic and application oriented researches.

Its partners are research institutes and industrial companies in Europe and Korea. Together with its partners, the KIST Europe solves problems and develops technologies which can be utilized on both continents. Its vision is to be the core of scientific and technological cooperation between Korea and EU countries.

The KIST Europe has grown from the small seed sown 13 years ago, and is now preparing for another powerful leap forward with the construction of a 2nd research building.

Over the next 10 years, the KIST Europe plans to further accelerate cooperation between Korea and EU countries, including Germany.

By the end of the next decade, the KIST Europe will have grown to be one of the most respected and top-quality R&D institutes recognized by EU community.

Facts & News

KESTCAP Meeting

April 20, 2010 - 2nd Symposium ‚Metabolites in Human Breath'

On April 20th, 2010, was organised in Dortmund. Moran than 30 participants from university hospitals, medical doctors and scientists using ion mobility spectrometry to identify and quantify human metabolites in breath discussed latest results and ideas for further progress.

Opening Ceremony

On April 30th, 2010, the new 2nd building was revealed to KIST Europe Forschungsgesellschaft mbH at the campus of the Saarland University.

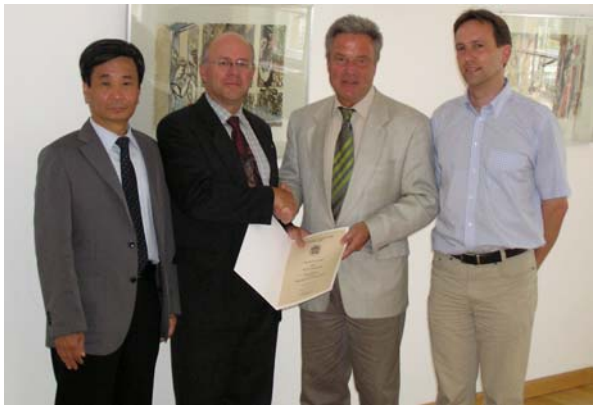
The building bears the name KIST - EU Cooperation Centre. More than 100 international guests took part in the opening ceremony.

The ‚Human Document Project' – 3 day-workshop

How can one preserve a document about mankind for one million years? National and international speakers coming from different disciplines took part in the international symposium held from June 30th to July 2nd at the KIST Europe premises.

In five working groups new ideas and projects have been discussed to find an answer to the question of how to preserve mankind's knowledge even after our civilization has been long gone.

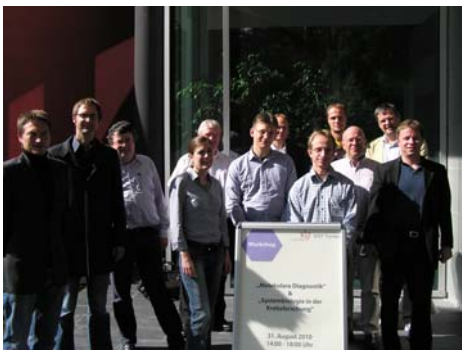
A booklet of the symposium will be issued at the end of 2010. The next symposium will take place at Standford, USA, in 2012: The Human Document Project

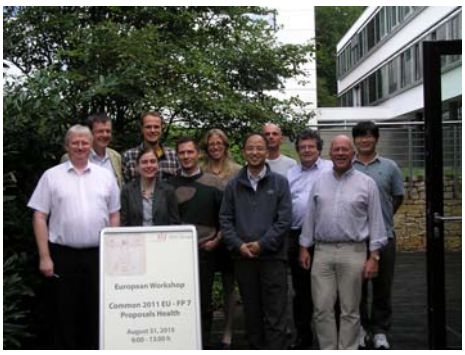


Professorship for Andreas Manz

On July 13, 2010 Dr. Andreas Manz, head of research at KIST Europe Forschungsgesellschaft mbH, was appointed to honorary professorship by the president of the Saarland University, Professor Dr. Volker Linneweber. The lectures on lab-on-the-chip-technologies started in October, 2010.

31.08.2010 BMBF Workshop Molekulare Diagnostik" & „Systembiologie in der Krebsforschung"





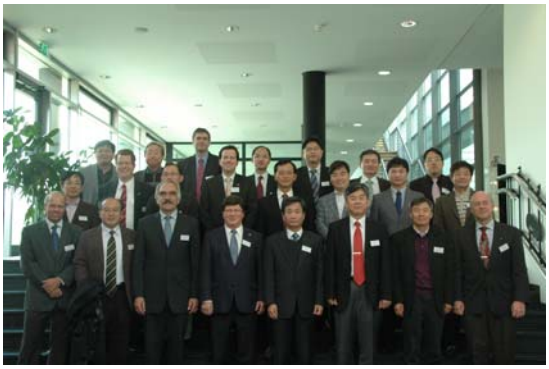
31.08.2010 EU-Workshop Common 2011 EU - FP 7 Proposals Health

The finding of common research proposals concerning actual calls of the BMBF and the European Union was in the center of the workshops organised at KIST Europe. Scientist from Austria, Poland and UK joint the workshops in the field of molecular diagnostics and breath analysis. In November 2010 the first project in the field of clinical diagnostics starts in cooperation with the medical departments of the Saarland University in Saarbrücken and Homburg.

Opening ceremony **µTAS Conference** (October 7-10, 2010 Groningen, NL) under participation of Prof. Dr. A. Manz (session chair) and presence of his Royal Highness Willem-Alexander of the Netherlands

25.-26.10.2010 Korea - EU High Level Meeting

To realise new ways to find potential cooperation partners and areas for common reasearch projects the first Korea - EU High Level Meeting was orgnised at KIST Europe. The directors and heads of different local and regional research institutions including ... and the heads of different departments of KIST Seoul came together for a 2-day-meeting in Saarbrücken. New potential ways to enhance existing and to make new contacts with respect to the mains fields of interest of KIST are discussed and will be realised in 2011.



Award for Mrs Jong-Ok Arnhold

Mrs Jong-Ok Arnhold was awarded a prize by the Minister of Education, Science and Technology which was handed over at EXPO 2010 at IlSan KINTEX hall on November 4th 2010.

This award was given to people who contributed to develop cooperation of academy-industry-institutes by participating or organizing activities in their organization.

This year 40 people won the prize after severe screening of distinguished experts renowned in industries, institutes or universities.

Mrs Arnhold is the first member of KIST Europe staff to receive an award from a Minister of the Korean Government.

Memorandum of Understanding

On November 9th, a Memorandum of Understanding was signed by Director Seong-ju Park of GIST Gwangju Institute of Science and Technology and Director Kwang-ho Kim of KIST Europe at Gwangju, Korea.

Both institutes agreed to pursue a long-term cooperation in information interchange, connection of network, the joint research of commercialization and the international cooperation field.

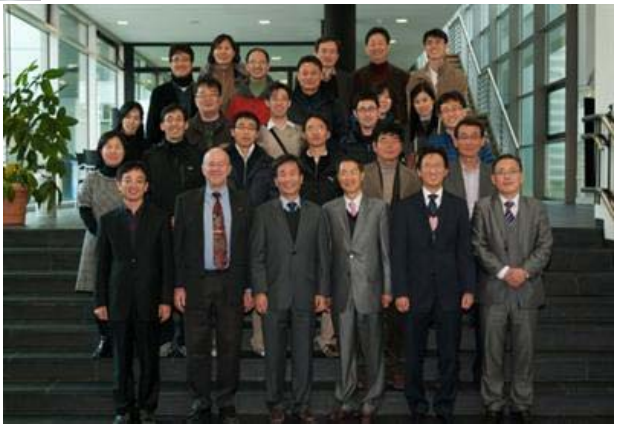
Collaborative Research Centres

Nov. 17th - positive assessment of Collaborative Research Centres - SFB 876 "Providing Information by Resource-Constrained Data Analysis" starts on January 2011. Prof. Dr. Sven Rahmann from TU Dortmund and PD Dr. Jörg Ingo Baumbach from KIST Europe are responsible for the Workpackage "Resource-Constrained Analysis of Spectrometry Data".

Visiting delegation

On November 26th a delegation of twenty people from the Korean Ministry of Education, Science and Technology visited our institute.

After a presentation of KIST Europe and discussion they were taken on a tour around the KOR-EU Cooperation building and the research facilities to see the research activities of KIST Europe.



Miniaturized PCR System for Infectious Disease Detection

PCR, silicon micro heater, field applications

We have designed an economical, battery-powered real-time polymerase chain reaction (PCR) system suitable for field and point-of-care applications. It has a built-in thermal management, a fluorescence-based detection system, and a single chip controller with a graphic touch-screen display. It runs four PCR reactions simultaneously allowing having two samples as well as positive and negative control.

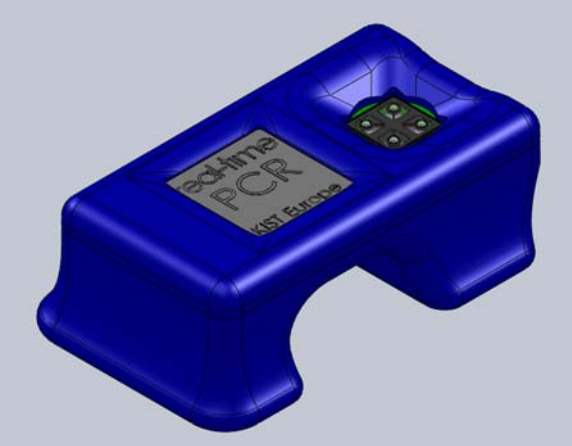


Fig. 1: Computer added design (CAD) of complete PCR system with the housing.

Successful containment, which could stop the spread of infectious diseases in developing countries, relies upon quick and accurate diagnostics. It can take days in certain parts of the world where samples must be sent to national laboratories with high-tech diagnostics. A portable point-of-care (POC) system that detects viral RNA through real-time PCR would increase the chances of detecting outbreaks quicker, leading to faster containment. This is especially important for developing countries where they cannot afford to purchase currently available expensive equipment. The devices we have designed is based on virtual reaction chamber previously developed in Singapore. The heater is made of micromachined silicon. The sample is in a form of microliter or sub-microliter sized droplet on a microscope cover slip placed on the top of the heater. The heater itself is non disposable part as it does not get into a contact with the PCR sample. The glass which is very cheap and gets into a contact with sample is disposable. This way we can have high performance system based on micromachined silicon concurrently with low operational cost.

The system being developed in KIST is a simplified version of previously developed system, much more suitable for the production. Its footprint is 3 – 4 times smaller, it will consume ¼ of electrical energy and the manufacturing cost will be 5 times lower. The targeted cost is 150 Eur per unit assuming large scale production. Also this is the first system compare to the older generations developed by us, which can run 4 samples a time. One negative control sample, one positive control sample and two real samples. Even this system can run 4 times more samples than the previous version, its electronics is much simpler. The heater control system was integrated so there is only one required to control temperature at four spots. Similar simplifications were also done regarding the optical read-out system.

The complete system was designed and partially manufactured. So far the silicon chip was designed and fabricated, electrical circuits were also designed, fabricated and currently the printed circuit boards (PSB) are being assembled. Once that is done, the PCB will be tested together with embedded software. The

Fig. 2: Assembled housing made by rapid prototyping technique with the electronics and display.

optical housing was designed, optical filters purchased. The housing for whole PCR system was also designed using CAD software (see Fig. 1) and test printed using rapid prototyping as shown at Fig. 2. We have designed a LabView-based software to test the system using PC. Once this testing is completed the algorithm will be transferred into an embedded system and tested performance of a complete device.

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Publications

[1]Pavel Neuzil, Lukas Novak, Juergen Pipper, Shinhan Lee, Lisa F. P. Ng and Chunyan Zhang, Rapid detection of viral RNA by a pocket-size real-time PCR system, Lab on a chip 2010;10(19):2632-4
[2]Neuzil Pavel; Cheng Fang; Soon Jeffrey Bo Woon; Qian Lan Liu; Reboud Julien, Non-contact fluorescent bleaching-independent method for temperature measurement in microfluidic systems based on DNA melting curves., Lab-on-a chip 2010;10(20):2818-21.

Nanodroplets in pseudocrystal arrangements

Nano-droplets can be generated out of a two phase flow at the junction between a nanochannel and microchannel. Depending on the independent flow rate of both phases, the nano-droplets will be able to form 3D hexagonal pseudocrystal organizations in microchannels. Phase change of these droplets (from liquid to solid) could enable us to generate a cheap column on chip which can be used for liquid chromatography purposes. In 2010, we managed to generate these pseudocrystals of oil nanodroplets in the microfluidic chip we designed.

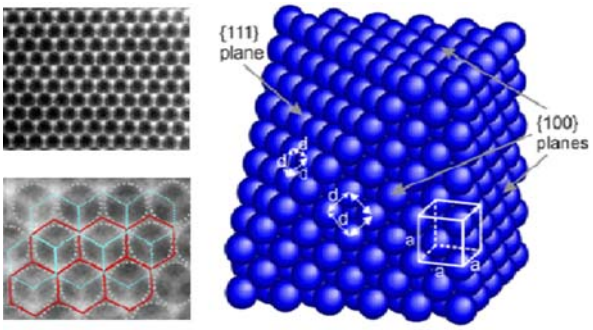

Fig. 1: Self organized hexagonal oil nanodroplet droplet arrangements in a microchannel (left) and the schematic presentation of the face centered cubic (fcc) crystal structure (right).

The last decade, nanotechnology developed in a tremendous manner. The raise of huge Clean Rooms filled with new technologies such as, nanoimprinting lithography, e-beam lithography, opens the door to this reasonable new world. This also opens the world to research on micro and in particular the nanometer scale. A wonderful example is the discovery of the organization of micro and nano-droplets in 3D arrangements or „pseudo crystals“ (see figure 1) generated out of a two-phase flow [1, 2]. By changing the phase of these pseudo crystals from a liquid into a solid phase, these pseudo crystals in a microfluidic column could function as a liquid chromatography column. Liquid Chromatography (LC) is a powerful technique that is widely used for sample preparations and analysis. These systems usually use columns which are packed with solid beads. The lifetimes of these expensive columns are limited. The high surface to volume ratio and the tunable nature of the nanodroplets offers clear benefits for LC separation where the droplets form the stationary phase for efficiently separation of small sample volumes. Pseudo crystals in a microfluidic channel could be integrated into a small and multifunctional chemical analysis system that are commonly referred as lab-on-a-chip (LOC) systems. It has been demonstrated that these systems enable very sensitive and reproducible analysis while using small sample volumes and low power consumptions compared to the conventional lab instrumentations. Therefore these LOC systems have become very attractive for many applications, such as point of care diagnostics, environmental monitoring, food monitoring.

Last year, we started the experiments by the design presented in figure 2A. The green lines are the microchannels, whereas the red line (C) is a nanochannel connected to the microchannels. A and B are representing the inlets through which the Hexadecane (**O**) and water with surfactants SDS (0.3%), Tween 80 (1%) (**W**), respectively, are pumped. The excess will leave through the outlets E and F, and a small part will be pressed into the meandering microchannel (D) via the nanochannel. At the junction of the nanochannel and the meander, oil droplets will be formed.

It took us a long period to optimize all parts in the setup mainly due to the design of the device. We managed to generate hexagonal packed pseudo crystals as presented in figure 2B. To minimize the time required for filling the microchannel with nanodroplet pseudo crystals, to keep them captured in one place in the microchannel, and to investigate the phase transition, a new design was made. This design will also be capable to test the generated column for LC purposes. The device will be manufactured and tested.

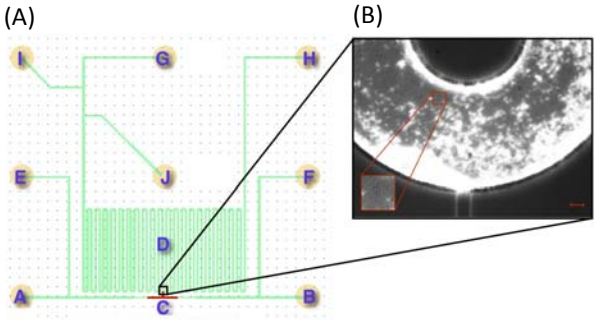

Fig. 2: (2A) A schematic drawing of the design. Several designs were made, varying only the dimensions and the length of the meandering microchannel (D). The dimensions of the device is 15 mm x 20 mm. A and B are the inlets through which O and W are pumped. The excess will leave through the outlets E and F. O and W will meet in the nanochannel (C) and at the junction between the nanochannel and the meandering microchannel (D), droplets will be generated. The sample can be electrokinetic injected by applying an electrical field between I and J and then switching the field to G and H will lead the mixture through the meander towards H.
(2B) Preliminary results of generating hexagonal packed oil droplets in a microchannel. The diameter of the droplets is 800 nm - 1 µm. The red bar represents 10 µm.

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Microfluidics for carbohydrate-based interactions

Carbohydrate interactions, microfluidics, CTC

A microfluidic system conjugated by carbohydrate beads has been designed, fabricated and characterized. This system has been tested in a competitive ELISA experiment performed on circulating breast tumor cells, CTC, and it has been shown the presence of galactose moieties and galectins on the cellular membrane. This work is combining, for the first time, microfluidics and glycochemistry.

Carbohydrates compose a large group of biomolecules with diverse structures and are found largely in the form of glycoconjugates inside or on the surface of cells. They mediate several processes; the distinction between malignant and normal tissue is manifest by the expression of a tumor related glycoconjugated. To better understand the role of those glycoconjugates, the microfluidics offers a powerful and not exploited tool, mimicking the environment where tumor and metastatic cells normally move.

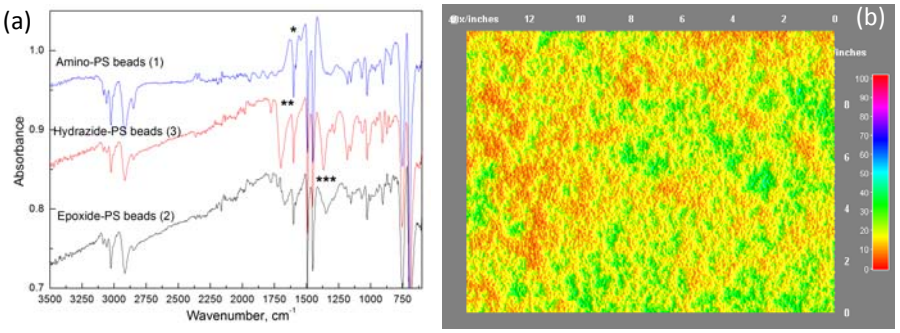

*Figure 1. a) Fourier Infrared spectra of amino, epoxide and hydrazide beads. Functional groups are detected respectively at *1570 cm-1: secondary amine, **1670cm-1: primary amine, *** 1300cm-1 epoxide. b) Gal-Peanut agglutinin FITC (Imagej 3D modif.). Brown and yellow peaks resemble the highest fluorescent signals due to the binding between the immobilized carbohydrate and the specific lectin.*

The fabrication and characterization of the microfluidic system is realized to isolate the CTCs and investigate the role of the glycoconjugate moieties in tumor progression and metastasis. Our microfluidic system is designed as a Hele chamber, and it is fabricated by assembling hydroxysuccinimide glass slide, prepared in our laboratory, double tape, PMMA sheet. Hydrazide beads are prepared from amino groups, through an intermediate epoxide, and are injected inside the chamber to form a covalent bond with hydroxysuccinimide esters. Then, the beads, used to enhance the possibility of multivalent interactions, are conjugated with the carbohydrate. To test the validity of our protocol of conjugation, fig. 1.a compares the infrared spectra of amino, epoxide and hydrazide beads. Each spectrum is the fingerprinting of each compound and functional group. Microfluidic chambers conjugated by galactose are incubated with

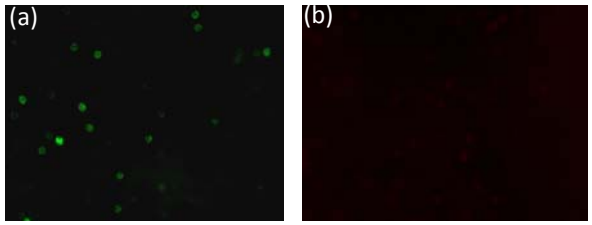

Fig. 2: Human fixed circulating tumor cells in microfluidic device after the washing. Fluorescent analysis performed with different channels: a) FTIC . b) TRITC.

Arachis hypogaea, PNA-FITC, a lectin recognizing the ß-galactose. The fluorescent analysis (fig. 1.b) shows that galactose interacts with the hydrazide forming the ß-anomer and it is recognized by the PNA. A competitive ELISA is performed with a sample containing CTCs from breast tumor, which has an aberrant expression of galectins, PNA-FTIC and UEAI-TRITC, vegetal lectin that specifically recognizes the fucose. The sample is incubated for 15 min and washed by connecting the chamber to a syringe pump. The results from the fluorescent analysis (fig. 2.a and b) show that the cells interact with the PNA-FTIC, whilst no signal on the TRITC channel is detected. Cells adhere on the galactose and at the same time, PNA finds and interacts with the galactose moieties on the membrane. The fluorescent analysis on recovered cells is also performed, but the recorded signal is slighter compared with one from the adherent cells (results not shown). The collected results leave still open several questions and show a complex scenario connected to the structure of the cellular membrane. The next goal is to use our microfluidic system 1) to identify the CTCs directly from the blood and 2) to correlate the glyconjugates and carbohydrates, present in the cellular microenvironment, to the metastasis and tumor progression.

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Publications

Simone, G.: Ca2+ Mediates the Adhesion of Breast Cancer Cells in Self-Assembled Multifunctional Microfluidic Chip Prepared with Carbohydrate Beads. Micro and Nanosystems 4, 2010.

Chronic Obstructive Pulmonary Disease and Breath Analysis

exhaled breath, volatile metabolites, trace gas analysis, COPD, lung cancer

Recently non-invasive methods for potential lung cancer diagnostics have been gaining increased interest. Within the present study the exhaled breath of 132 persons was investigated using an Ion Mobility Spectrometer (IMS) coupled to a Multi-Capillary Column (MCC) without any pre-separation or pre-enrichment. 104 different peaks were considered within the IMS-Chromatograms of the 10 mL breath samples. It was found, that a single analyte allowed a separation of the healthy persons and the COPD patients (with and without lung cancer). The positive predictive value obtained was 95%. The peak was characterized as cyclohexanone (CAS 108-94-1).

Chronic obstructive pulmonary disease (COPD) is an inflammatory condition characterized by oxidative stress and the formation of volatile organic compounds (VOCs) secreted via the lungs. Therefore, the analysis of VOCs might be highly relevant in the diagnosis of COPD. A complete description of the volatiles associated with COPD has yet to be developed. Recently, some studies have identified groups of volatiles and other biomarkers in COPD patients that have potentially useful relationships to cell degradation processes.

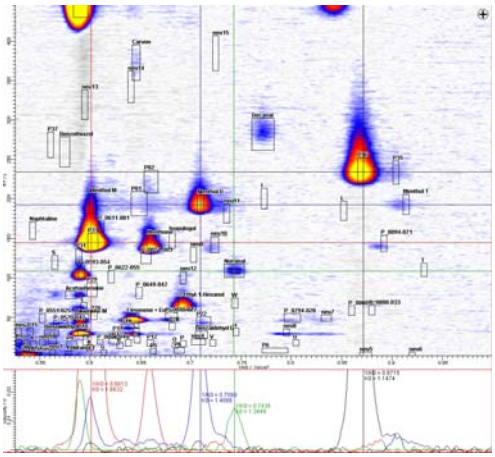

Fig. 1: A typical IMS-chromatogram showing the peak-regions markings which were used in this investigation – single spectra below.

In total, 132 persons were included in the study of which 97 had a COPD (35 COPD without Bronchial Carcinoma, 62 COPD with Bronchial Carcinoma) and 35 were healthy volunteers. In each case end-tidal breath, controlled by a flow sensor, was collected in a sample loop of 10 mL volume. The content of the sample loop was then fed into the inlet of a MCC and transported to the IMS after pre-separation. The MCC and the drift tube IMS were held constantly at 30°C. The peaks were characterized using the software VisualNow. All 104 peaks are characterized by their position with drift time (corresponding $1/K_0$-value) and retention time and their concentration related to the peak height – see Figure 1.

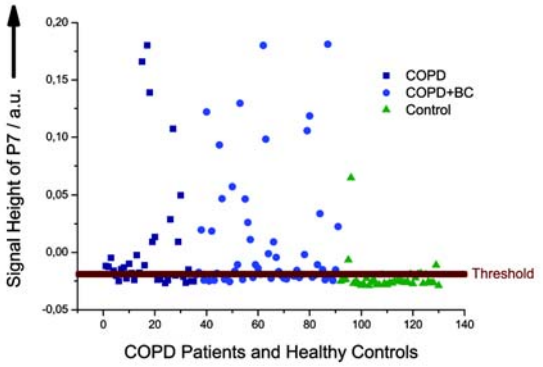

Fig. 2: Classification of the two groups by definition of a district above/below a specific signal height related to the concentration of a single analyte

Using the threshold defined within Figure 2, a contingency table was obtained. The observed sensitivity was about 60%, but the specificity was 91% and especially a really high positive predective value of about 95% was observed. Therefore, obtaining a value of the considered peak beyond the threshold is a high indicator for COPD. However, the classification below the threshold has no predictive power. The peak considered was subsequently identified as relating to cyclohexanone (CAS 108-94-1) using parallel measurements using a GC/MSD. Therefore, a concentration of cyclohexanone above the threshold could be seen as an indicator for COPD. Naturally, the identity of the peak used for separation of the two groups must be validated with a greater population and external standards.

Summarizing, breath gas analysis using ion mobility spectrometry offers a chance for separation of healthy persons and COPD patients using a single analyte at a defined concentration.

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Cooperation with the lung clinic hemer

Publications

Westhoff, M.; Litterst, P.; Maddula, S.; Bödeker, B.; Rahmann, S.; Davies, A.N.; Baumbach, J.I.: Differentiation of chronic obstructive pulmonary disease (COPD) including lung cancer from healthy control group by breath analysis using ion mobility spectrometry Int. J. Ion Mobility Spectrom. 13, 131-139 (2010).

Bronchoscopically obtained volotile biomarkers in lung cancer

exhaled breath, flexible bronchoscopy

Detecting volatile organic compounds with ion mobility spectrometry in exhaled breath of lung cancer patients is feasible either over a mouth piece or bronchoscopically via a Teflon tube. The composition of VOCs in the lung cancer bearing lung is different from that of the contralateral lung, indicating that these VOCs originate at least partly from the tumour. VOCs might permit distinguishing different tumour types. Different patterns of VOCs represent different metabolic pathways specific for tumour types.

To date the origin of the VOCs (volatile organic compounds) in patients with lung cancer remains unclear. They could be products of the tumour metabolism which are exhaled either directly or via the pulmonary or bronchial circulation. An alternative explanation might be that cells or bacteria, interacting with the tumour, release metabolic products. Quite often there is necrosis around a tumour and what we find could represent an unspecific bacterial or necrosis reaction. A third explanation may be that these VOCs represent a pathophysiologic reaction on the tumour elsewhere in the organism. These systemic compounds are supplied through blood flow and are cleared from the body by excretion through the lungs after diffusing into the alveoli. And another explanation could be that these substances are representing an underlying disease or condition as chronic obstructive pulmonary disease (COPD) or smoking habits.

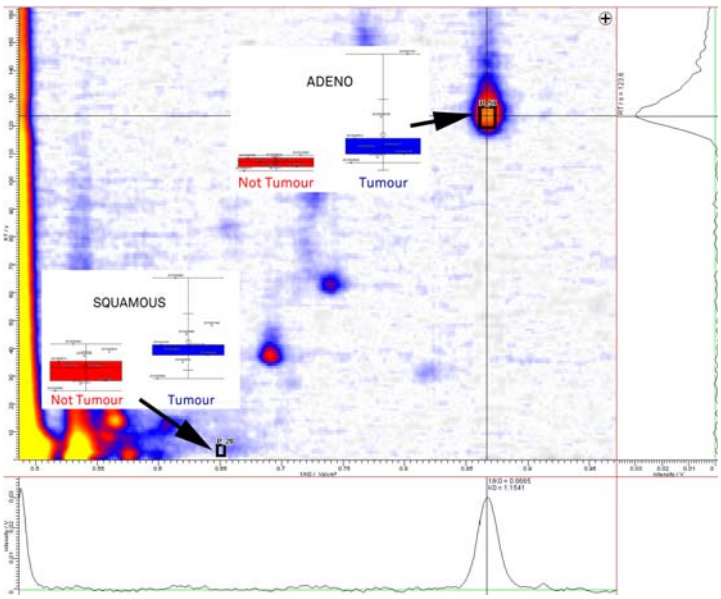

Fig. 1: IMS-chromatogram of a sample taken directly in the lung during bronchoscopy inlet: to peaks selected are related to different types of lung cancer

Therefore, a bronchoscopic approach with examination of exhaled breath in the affected and in the non-affected lung of the same individual with lung cancer may contribute to this field. The aim of the present study was to evaluate the feasibility of this method and to assess if the exhaled breath in patients with unilateral lung cancer contains the same VOCs in both lungs. The IMS coupled to a multi-capillary column (MCC/IMS) used was a BioScout (B&S Analytik, Dortmund, Germany) consisting of the MCC/IMS and a SpiroScout (Ganhorn Medizin Electronic, Niederlauer, Germany) as sample inlet unit. In this spectrometer a 550 MBq ^{63}Ni ß-radiation source was applied for the ionisation of the carrier gas (air). It was connected to a polar multi-capillary column (MCC, type OV-5, Multichrom Ltd, Novosibirsk, Russia) used as the pre-separation unit.

In nineteen lung cancer patients, exhaled breath was aspirated via the working channel of a flexible bronchoscope from both the tumour bearing and the opposite lung and analyzed with IMS. We found two peaks which were significantly higher and three peaks which were significantly lower on the tumour site. We also found different VOC concentrations depending on the histologic subtype. The results indicate that VOCs in lung cancer patients are produced locally in or around the tumour and it is most likely that these VOCs represent underlying metabolic processes of the tumour. We found 5 peaks which were significantly different between the tumour bearing lung and the opposite lung depending on the histology. In our study of eight patients with adenocarcinoma, peak 59 was found to be significantly higher in the tumour bearing lung (Fig. 1). In three patients with undifferentiated Non Small Cell Lung Cancer (NSCLC), two peaks could be detected which were lower on the tumour side. And in nine patients with squamous cell carcinoma or adenosquamous cell carcinoma we found another two peaks. One of them is peak 28, which had a higher value in the lung with the tumour (see inlet in Fig. 1).

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Cooperation with the Ruhrland-Clinic Essen

Analysis of expression level of specific DNA regions in patients with AS

Ankylosing Spondylitis, Quantitative real-time PCR, CDC42 binding protein kinase beta

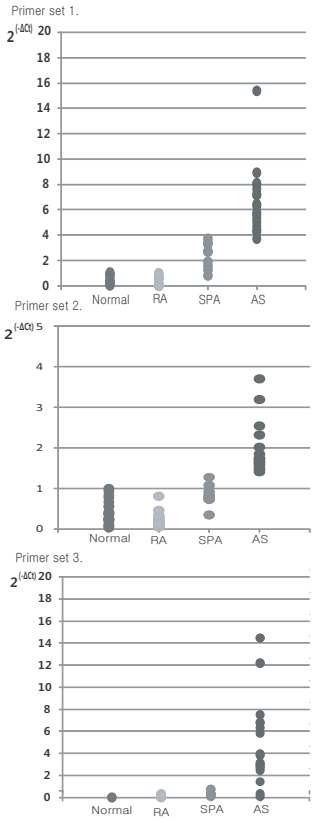
To identify the association of CDC42 binding protein kinase beta (CDC42 BPB) genes and AS (ankylosing spondylitis) in Korean ankylosing spondylitis (AS) patients, expression level of specific DNA regions from peripheral blood mononuclear cells (PBMCs) of 17 AS patients, 20 RA(rheumatoid arthritis) patients, 9 SPA(spondylo-arthropathies) patients and 23 healthy donors was analyzed by quantitative real-time PCR (Q-PCR). In previous study, we proposed a hypothesis about insertion of CDC42 BPB gene in Korean AS patients PBMC samples. Q-PCR results demonstrated unique expression pattern in Ig VH genes from peripheral blood of AS patients was performed with primers corresponding from us.

Peripheral blood (PB) was collected from healthy controls and from patients with AS patients with RA (rheumatoid arthritis) and patients with SpA(spondylo- arthropathies) who visited the rheumatology clinic at Gachon University Gil Hospital. PB was collected into sterile, heparinized tubes. PB mononuclear cells (PBMCs) were isolated from whole blood using a Ficoll–Hypaque gradient. Total RNA was isolated from PBMCs by RNAeasy mini kit (Qiagen, Hilden, Germany) and cDNA was synthesized by Maxime™ RT PreMix (Oligo(dT)15 primer) Kit (Intron Biotechnology, Korea) following manufacturers' instructions.

		Forward primer		Reverse primer
1) primer	VH 2* For	5'-CAG ATC ACC TTG AAG GAG TCT GG-3'	JH Rev	5'-TGA GGA GAC GGT GAC CAG GGT GCC-3' 5'-TGA AGA GAC GGT GAC CAT TGT CCC-3' 5'-TGA GGA GAC GGT GAC CAG GGT TCC-3' 5'-TGA GGA GAC GGT GAC CGT GGT CCC-3' 5'-TGA CCG TGG TCC CTT GGC CCC AGA-3'
2) primer	VH Leader For	5'-CR CTC CTG CTG CTG ACC A-3' 5'-CR CTG AGC TGG RTT TTC CT-3' 5'-KR CTY YGC YGG SYY YYY CT-3'	CDC42bk Rev	5'-TG CTC TGT AGT GTC AA-3'
3) primer	CDC42bk For	5'-GAG CAC TGG CCA AGC ACT A-3'	CH epsilon	5'-CGG ATG GGC TCT GTG TGG-3'

* Leader;VH-L variable reign leader sequence; CH:constant resion; CDC42bk CDC42 bindingkinase

In our previous study (Exp Mol Med. 2010;42(5):319-326), two novel VH forward primers, which we refer to as VH2*a and VH4*a forward primers for Q-PCR, were added to VH PCR primer sets has used. As followed our previous literature, specific DNA region was over expressed in patients with ankylosing spondylitis and the sequence of which is in accordance with CDC42 binding protein kinase beta (CDC42 BPB) genes. Successively, we designed two more primer sets were based on the result (figure 1) and through some sets of experiments, finally we proposed a hypothesis: the insertion of specific region which we found could be a useful biomarker of disease. To verify this hypothesis, we performed quantitative real-time PCR (Q-PCR) with primer sets which can be seen in Figure. 1 in 17 AS(ankylosing spondylitis) patients, 20 RA(rheumatoid arthritis) patients, 9 SPA(spondylo-arthropathies) patients and 23 healthy donors cDNA from peripheral blood samples. The amplification condition was 95°C for 30 sec, 50-60°C for 1 min, and 72°C for 1 min for 30-40 cycles. The relative amount of transcripts of target genes compared to those of a housekeeping gene was calculated as follows; ΔCt=Ct(experimental)-Ct(housekeeping), R=2-(ΔCt). In comparison of expression level of specific DNA regions which produced by our primer sets were significantly high in ankylosing spondylitis patient group (Figure 2). This may imply that our primer sets coded region could be crucial role of disease pathogenesis, and it also indicate that this region could be a useful biomarker of disease albeit with further investigation.



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Publications

Patent - Primer for diagnosing ankylosing spondylitis and kit for diagnosing ankylosing spondylitis comprising the same, 8 Jan 2010 Inventor: CH Nam, YJ Kim, HJ Baek

VH2 overexpression and unique rearrangement in immunoglobulin variable heavy chain genes from peripheral blood of ankylosing spondylitis patients. Exp Mol Med. 2010 May 31;42(5):319-26. Kim YJ, Kim NY, Lee MK, Choi HJ, Baek HJ, Nam CH.

Controlled adsorption of the fd phage on the SiO_2/Si substrate

fd phage, adsorption, alignment, 3-aminopropyltriethoxysilane (APTES), AFM

The controlled adsorption of the fd phage on the SiO_2/Si substrate with different conditions was studied with non-contact AFM analysis. The fd phage at high pH (~ 9.0) were well-adsorbed on the SiO_2/Si surface that was functionalized by APTES, while those at low pH (~ 3.0) were well-adsorbed on the cleaned SiO_2/Si surface. Interestingly, the well-ordered structures of the fd phage at intermediate pH (~ 7.0) were discovered by non-contact mode AFM analysis.

The adsorption and the alignment of fd phage with different dilution concentrations onto a SiO_2/Si substrate were controlled by pH and chemically functionalized groups (APTES) and were studied with non-contact AFM analysis.

The AFM images in Fig. 1b, 1c and 1d with high pH (~ 9.0) reveal that this adsorption process between the fd phage and the SiO_2/Si surface can be controlled by modifying the dilution concentration similar to that used for nanoscale inorganic materials such as vanadium pentoxide (V_2O_5) nanowires or organic carbon nanotubes. Fig. 1a shows a schematic illustrating how a fd phage can be well attached to the SiO_2/Si surface functionalized with amine-terminated APTES molecules at high pH (~ 9.0). .

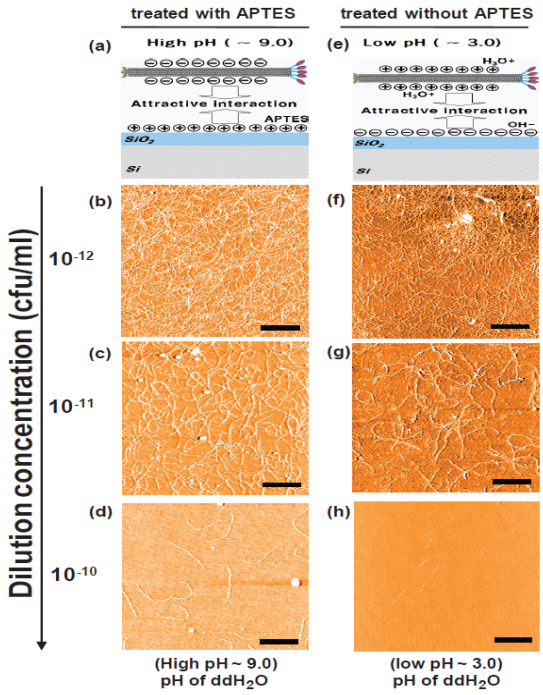

Fig. 1: Non-contact AFM images of the adsorbed fd phage on the SiO_2/Si substrate as a function of the pH and the dilution concentration.

In contrast, the fd phage at low pH (~ 3.0) were well-adsorbed onto the cleaned SiO_2/Si surface without any treatments (Fig. 1f, 1g and 1h). It can be explained by the good binding affinity between the fd phage covered with H_3O^+ ions and the SiO_2/Si surface with hydroxyl groups (Fig. 1e).

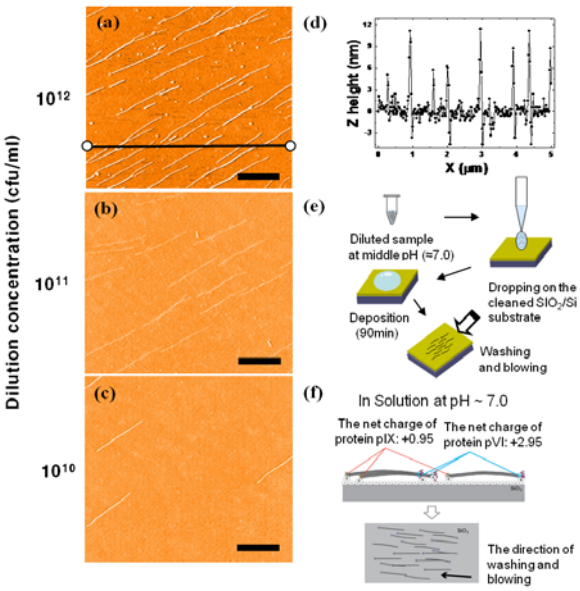

Fig. 2: Non-contact AFM image of the well-aligned fd phage on the cleaned SiO_2/Si substrate as a function of the dilution concentration at intermediate pH (~ 7.0).

Interestingly, the well-ordered structures of the fd phage were discovered by non-contact mode AFM analysis due to the locally positively charged coat protein of the fd phage and the shear forces at intermediate pH (~ 7.0) (Fig. 2a, 2b and 2c). The height profile (Fig. 2d) along the black line in Fig. 2a shows most of the aligned structures consisted of bundle-shape structures. This type of structure can be explained to be from the interaction between the locally positively charged coat protein pVI and pIX of the fd phage (the net charge of pVI and pIX in pH 7.0 are +2.95 and +0.95, respectively). Furthermore, the strongly negatively charged SiO_2 in the intermediate pH (~ 7.0) solution might help the phage to interact with each other rather than to bind to the cleaned SiO_2 surface.

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Publications

1. Hwang, K.H.; Jeon, D.Y.; Park, S.J.; Kim, Y.J.; Joo, M.K.; Ahn, S.E.; Kim, G.T.; Nam, C.-H.: Controlled surface Adsorption of fd Filamentous Phage by Tuning of the pH and the Functionalization of the surface. 23rd European Conference on Biomaterials 2010, Tampere Hall, Tampere, Finland, September 11-15, 2010

2. Jeon, D.Y.; Hwang, K.H.; Park, S.J.; Kim, Y.J.; Joo, M.K.; Ahn, S.E.; Kim, G.T.; Nam, C.-H.: Controlled Surface Adsorption of fd Filamentous Phage by Tuning of the pH and the Functionalization of the Surface. Journal of Applied Physics. In press.

A novel chemo-immunotherapy approach for the treatment of cancer

Adoptive T cell transfer, intracellular drug transport, polymeric drug encapsulations

The Cellular Immunotherapy team aims at developing a next generation cancer therapy which combines adoptive T cell transfer with a retargeting strategy and innovative drug delivery systems for intracellular transport of pharmaceuticals. In 2010, we analyzed whether functionalized peptide polymers and polyester-based drug encapsulations can be utilized as intracellular carriers for a potent anti-neoplastic agent.

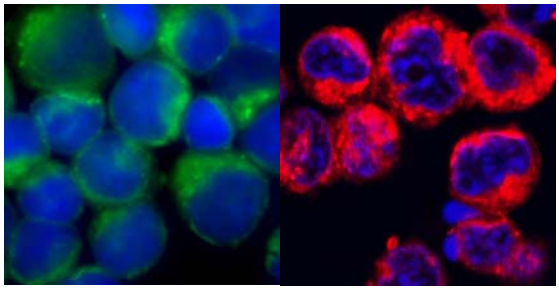

*Fig. 1: Ex vivo activated human T lymphocytes loaded with **ligand-modified, fluorescein-labelled peptide polymers** (A) and **idarubicin-containing polyester nanoparticles** (B). Polymer/particle uptake was analyzed by epifluorescence (A) and confocal microscopy (B), respectively.*

The research focus of the Cellular Immunotherapy team is a novel cancer therapy approach which combines the specificity of immune cell-based strategies with the high efficacy of chemotherapies. The new concept aims at enhancing the cytotoxic effect of ex vivo activated T lymphocytes from cancer patients by loading them with anti-neoplastic drug-containing nanoparticles. To ensure tumor targeting in vivo, the drug-loaded T cells are reinjected into the patients in combination with a bispecific antibody recognizing both carcinoma cells and T lymphocytes. When the bsAb cross-links effector and target cells at the tumor site, the natural cytolytic activity of the T lymphocytes is induced.

Innovative biocompatible polymers are utilized to prepare drug-enclosing nanoparticles (NPs) for our specific intracellular application. The drug encapsulations have two main functions: They have to protect the carrier cells from the toxic effect of the pharmaceutical, and they should enable time-controlled release of the drug at the target site. Ideally, the anti-cancer drug is liberated, after the effector cells have fulfilled their natural cytolytic function. So, tumor cells will be eliminated through the consecutive action of cytotoxic T lymphocytes and the delivered anti-cancer agent.

Last year, the Cellular Immunotherapy team has evaluated the efficacy of numerous polymer* and nanoparticle# preparations using ex vivo activated T cells from healthy donors. Upon loading, different in vitro tests were performed in order to determine the optimal particle concentration and incubation time and to analyze parameters such as uptake efficiency and T cell viability, respectively.

Flow cytometric and fluorescence microscopy studies revealed that a functionalized peptide polymer preparation as well as several polyester nanoparticles enclosing the anti-neoplastic drug idarubicin are internalized very efficiently by activated human T cells (see figure 1). However, loading with encapsulated idarubicin significantly impairs T cell viability strongly suggesting that the intracellular stability of the nanoparticles prepared so far is not sufficient (figure 2).

Taken together, we could show that activated human T lymphocytes efficiently take up newly developed anti-cancer drug-containing polyester nanoparticles. However, a protective effect of the drug encapsulations was not observed. To enable preparation of

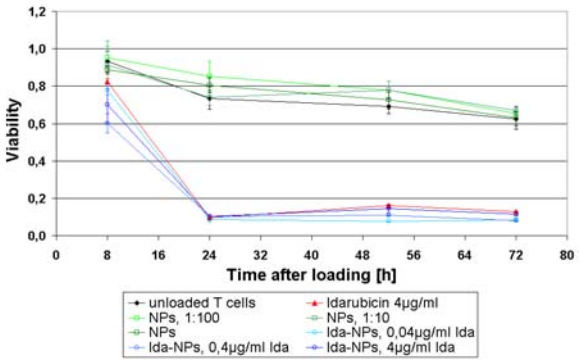

Fig. 2: Exemplary XTT colorimetric assay showing that loading with idarubicin-polyester NPs impairs T cell viability (Y axis = arbitrary units).

adequate intracellular drug carriers for the combined chemo-immunotherapy approach, optimized polymers and encapsulation strategies will be developed.

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* Polymers synthesized, purified and analyzed by the group of Prof. G. Wenz, Organic Macromolecular Chemistry, University of Saarland, Saarbruecken, Germany

\# Idarubicin-loaded polyester nanoparticles prepared and characterized by the group of Prof. C.-M. Lehr, Biopharmaceutics and Pharmaceutical Technology, University of Saarland, Saarbruecken, Germany

Digital Cell Dispenser (DCD) for Cell-based HTS

Dispenser, Droplet, Single Cell Assay, HTS, µ-array

Aim of this project is the development of a novel cell dispenser unit capable of applying accurate and reproducible numbers of viable cells in a droplet. This dispenser is integrated in a modular way including micro cell counter, droplet dispenser, micro valves and cell collector unit as replaceable parts. Single or controllable number of cell dispensing is essential for reproducible quantity measurement for cell-based assays in drug discovery applications as well as general bio-medical laboratory works.

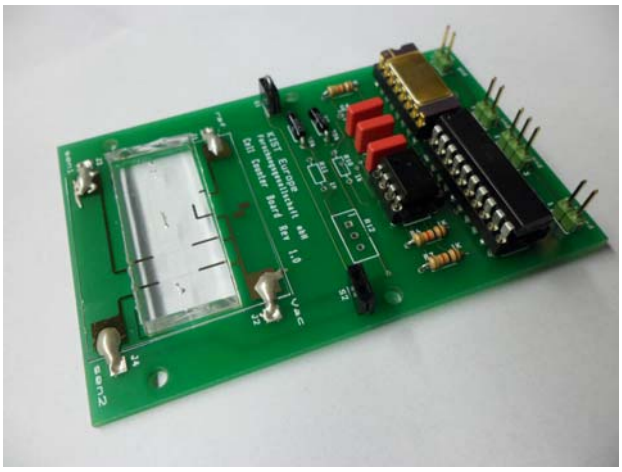

Fig.1: Short facing cell counter chip and sensor electronics

As shown in figure 1, the cell counter module which has short facing electrode has been developed. The micro cell counter is fabricated by 3 steps. First step is making PDMS channel using soft lithography. Next step is making electrode layer using gold/chrome etching. Bonding of PDMS channel and electrode layer is followed after plasma treatment and heating. When a particle (or cell) passes on electrode in micro channel, small change of impedance of electrode pair can be detected using AC bridge circuit. Instrument amplifier (AD624) which has very high CMRR and demodulator (AD630) are used in AC bridge circuit. Detection signal can be observed by oscilloscope in real time and acquired by DAQ board (NI-6221) at the same time.

Figure 2 shows a SEM photo of the cell collector module. The design of the cell collector has been changed from the proposed 3D concept to a much simpler 2D configuration. The reason therefore was the ease of fabrication and the possibility to combine easily cell counter and nozzle with cell collector in future. The cell collector chip has an outer dimension of 15 mm by 45 mm which is given by a chip holder from company Micronit. Five fluidic ports are needed: cell inlet, media outlet, waste outlet, injection inlet, dispensing outlet. The functional structure consists mainly of 129 channels that get narrower following the flow direction of the cell suspension. These shapes are designed to trap polystyrene particles of 6 or 9 µm diameter and cells. The channel height is 20 µm in 20 µm thick dry film photo resist

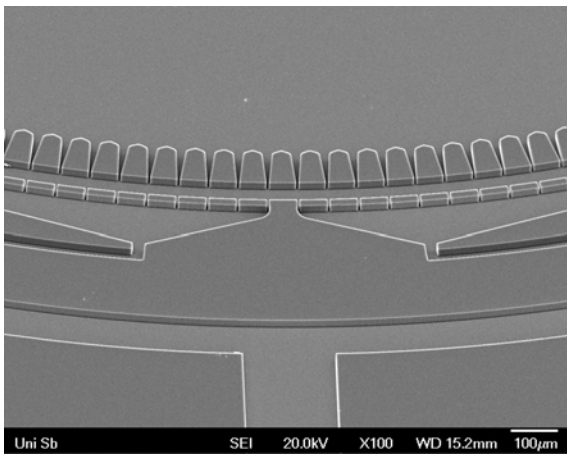

Fig.2: SEM photo of the cell collector module. Small gaps between structures are 4.6µm

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Publications

Holger Krause, Jin-Young Kim, Jihwang Park, Michael Müller, Jungtae Kim, Geunbae Lim and Helmut Seidel, “Electrode Design for High Impedance Change of Coulter Based Cell Counter,” Lab-on-a-chip World Congress, San Diego, Oct., 2010

Bio Cell Processor for Drug Discovery

Cell adhesive array, cell patterning, μTAS, Lab-on-a-chip, Cell-based Assay

Several arrays of micro cell adhesive patterns on PDMS have been fabricated and demonstrated with pattern surfaces of organic-inorganic hybrid resin which is classified by the amount of ingredients such as MPTMS and PEGDM. Therefore HR3.5, HR4 and HR4-DPA for immobilizing of cell have been tested with shape and size of patterns which are rectangular or hexagon and sizes of 5, 10, 25, 50 and 100μm. The arrays of patterns have been fabricated by PDMS soft lithography and micro contact printing and demonstrated by HeLa, T-cell, Jurkat cells.

As shown in figure 1, micro cell patterns can be realized by different methods according to the type of PDMS mold from whether positive photoresist or negative photoresist. The methods were selected by three shapes of micro cell patterns: (1) micro cell adhesive structures, (2) micro cell adhesive patches and (3) micro cell adhesive wells.

In figure 2, the experimental results showed that most of the 25μm-sized wells housed at least a single adhered cell meanwhile higher concentration ($2.0x10^6$ cells/ml) of cell in suspension resulted more immobilization. Hexagonal-shaped wells showed higher attached cell numbers in size of 50 and 100μm than rectangular ones. With regards of well depth, 10μm deep patterns showed lower numbers of occupied wells than 25 and 40μm depth. Even though no difference could be observed between 25μm and 40μm depth from the 50μm- and 100μm-sized wells, the 25μm-sized wells with only 25μm-depth displayed better cell adhesion performance than other depths.

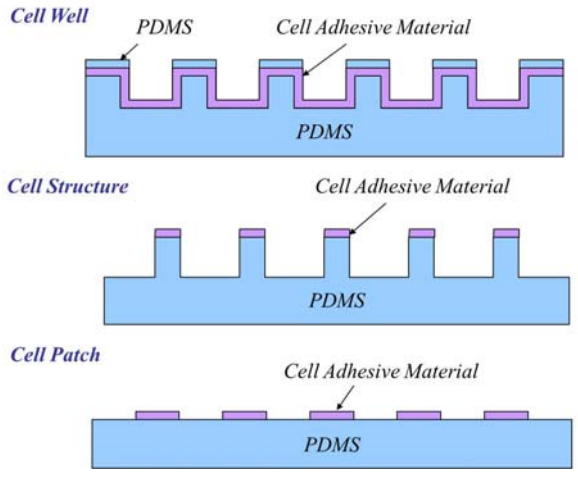

Fig.1: Types and methods of the cell adhesive patterns.

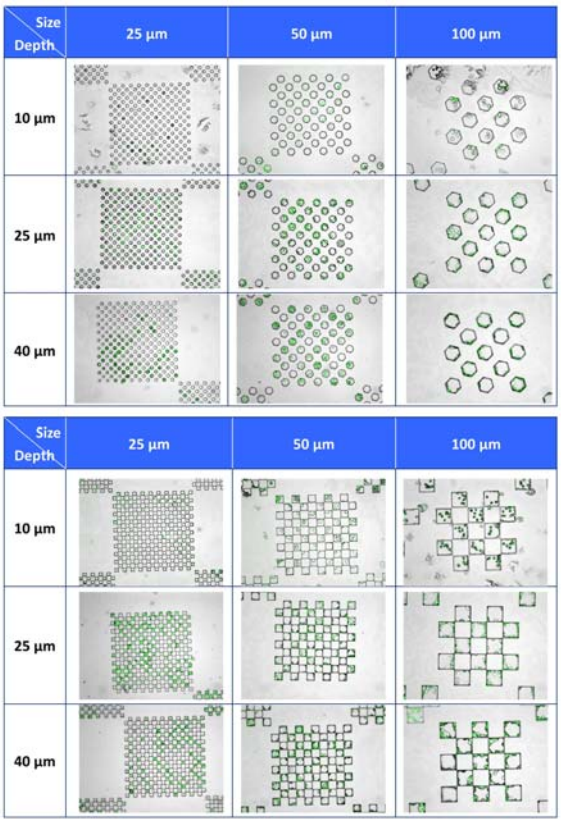

Fig.2: Cell immobilization results with hexagonal patterns (above) and rectangular patterns (below). Green dots inside of wells indicate labeled HeLa cells which was injected from $1x10^6$ cell/ml suspension and 2 times of 5 minute washing with 300rpm after 6 hours incubation.

We can conclude that the dimension of cell adhesive micro well are related to the cell attachment mechanism: the size of wells to cell entry and cell numbers in the wells, the shapes of wells to the location of adhered cells, and the depth of wells to the numbers of the adhered cells.

The future study includes construction of a micro cell analysis system with better dimensional parameters which provide sheath flow to the cell loading stream to increase cell concentration and reduce cell lose to micro cell well array

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Publications

Park, J.; Müller, M.; Jang, E.; Hong, L.-Y.; Kim, J.; Koh, W.-G.; Kim, D.-P.; Seidel, H.: "Effect of Dimension of Micro Cell Wells Coated with Inorganic-organic Hybrid Resin on Cell Attachment," Lab-on-a-chip World Congress, San Diego, Oct., 2010.

Park, J.; Müller, M.; Jang, E.; Kim, J.; Hong, L.-Y.; Kim, D.-P.; Seidel, H.; Koh, W.-G.: "Fast Cell Immobilization by Using Non-immunological Method for Cell Based Biosensor," The 9th Annual IEEE Conference on Sensors, Hawaii, Nov., 2010.

Korean-German Industry Collaboration leading by KIST-Europe

Industry collaboration, product development, Commercialization.

A Successful international collaboration between Korean-German Industries which achieves development of new products and its market with great economic potential is being performed by leading of KIST-Europe. These 3 collaborative partners, KIST-Europe, German industry, Korean manufacturer are working in "idea-to-market" process effectively. Since 2007 of the first product development project, the second and third projects are on-going with several achievements such as prototypes of new product, 1 patent and 4 other patents in pending.

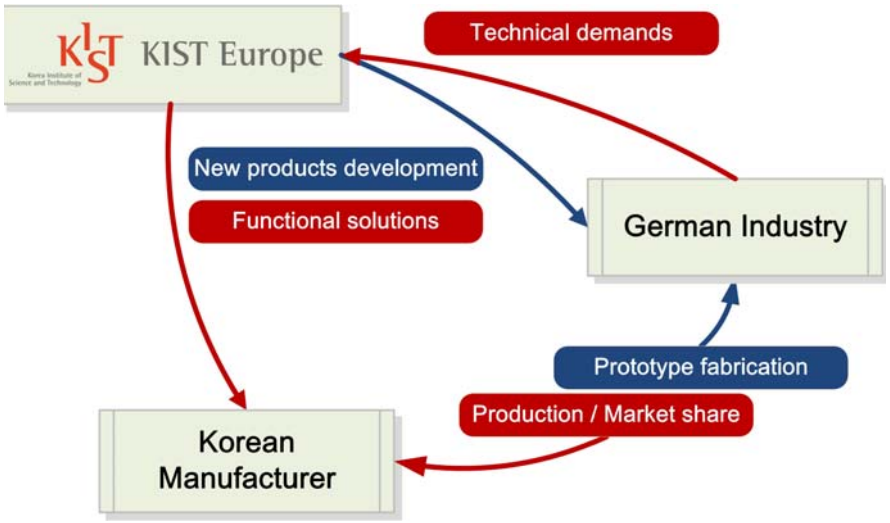

Fig.1: Collaboration roadmap

As collaboration roadmap is provided, from Bio-MEMS Team of KIST-Europe the functional solutions and new ideas were applied as a new product from demands of local German industry partner. The Korean manufacturer is also involved in development of the prototypes of the ideas and testing as well as mass production and market share of the new product.

The typical but ideal development process including international collaboration, idea-research-product development-economic production-market development has been achieved effectively by close co-working and leading performance of KIST-Europe. Furthermore, 2nd (new type of medicine storage) and 3rd (development of new medicine compounds) researches are on-going since the first collaboration project has been finished.

For further tasks of other industrial product/technology development, Bio-MEMS team uses this strategy continuously so that the industry partners can adapt highly developed Micro-Nano technologies to their product and possibly step in Korean market by KIST-Europe's guide.

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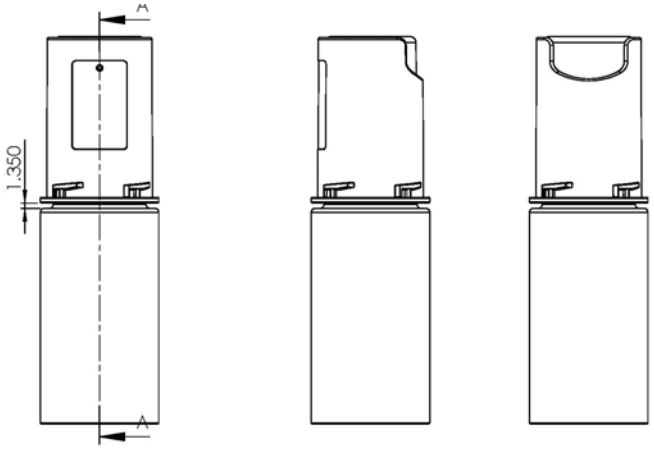

Fig.2: Prototype of the new product

Korea-EU Energy Technology Cooperation Network Program

International Cooperation, Energy R&D, Korean and EU Energy R&D Programs

Korea-EU Energy Technology Cooperation Network Program is a project funded by KETEP (Korea Energy. Technology Evaluation and Planning), a funding agency of the Korean Ministry of Knowledge and Economy, which aims at facilitating the exchange of information & experts, promoting Energy R&D, and supporting technology transfer and commercialization between Korea and Europe.

Fig. 1: MOU between KETEP and KIST Europe

The overall aim of the Korea-EU Energy Technology Cooperation Network Program is to establish a solid foundation for mutual collaboration in Energy R&D between Korea and the EU on the level of governmental funding agency.

Within the project, it will be achieved by

1) publishing promotional materials on Korea-EU Energy R&D Cooperation,
2) finding measures to raise awareness in Korea-EU Cooperation in energy technologies, and
3) providing information on cooperation opportunities.

In the first year of the project period, building a collaboration network between Korea and the EU will be especially focused. In addition, an annual education and training program will be organized for the Korean academia, industry, and research institutes that are interested in collaborating with European actors in the area of energy technologies.

To set up a communication channel between two countries, MOU activities between Korean and the European institutions and participation in the events organized by international organizations such as IEA will be supported.

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Fig. 2: Meeting for collaboration in Energy R&D between KETEP and European Commission

KORRIDOR (FP7)

International Cooperation, Korean R&D and Innovation Programs, ACCESS4EU

KORRIDOR (Stimulating and facilitating the participation of European researchers in Korean R&D programs) project (Dec. 2009 - Nov. 2011), as one of eleven ACCESS4EU projects, aims to widen and strengthen the RTD cooperation between Korea and the EU in common research areas of interest by opening up access opportunities for European researchers in Korean national RTD programs, facilitating joint research initiatives supported by the Korean side and contributing to the improvement of the cooperative climate between the EU and Korea.

Korea is one of the most important RTD partners of the EU with well established legal frameworks for cooperation. However, the level of public awareness of cooperative opportunities for European researchers in Korean RTD Programs is still very low. The KORRIDOR project develops and organizes various activities to promote cooperation between Korean and the EU with three objectives:

- To map in a structured way the existing access opportunities for Europeans in Korean RTDI programmes
- To facilitate participation by setting up a Helpdesk service for European participants and a RTDI database featuring information on current South Korean programmes open for European researchers
- To raise awareness of the access opportunities for European organizations/ researchers in Korean RTD programmes

In 2010, as the first year of the project, the KORRIDOR project has developed a policy paper that introduces the participation regime of Korean RTD programs, studies existing problems and suggests recommendations. A participation guideline and FAQs about access

Fig. 1: KORRIDOR consortium members at the kick-off meeting on 22nd of January, 2010, in Saarbrücken, Germany

opportunities for EU researchers in Korean RTD program also have been developed and will be published early 2011. For the dissemination and liaison-building, the KORRIDOR project provided a training workshop for EU scientific officers, Korean NCPs and programme managers, and European researchers working in Korea at Seoul in 6th of October 2010. Next year, at least three Korean RTD workshops at major European Conferences will be held for these purposes.

To provide fast and up-to-date information, the KORRIDOR project has created a website on the common web portal for the ACCESS4EU projects (http://www.access4.eu/southkorea/). To facilitate European researchers' participation in Korean RTD programmes further, the KORRIDOR project plans to provide close and free consulting and advising services on access opportunities, legal, organizational, financial and cultural issues and available supporting mechanisms, in the form of Helpdesk services. This Helpdesk additionally will monitor the participation of European researchers in Korean RTD programs and distribute this information to all stakeholders.

In the long term, the KORRDIOR project will contribute to initiating necessary improvements in the framework for European participation in Korean RTD programs by identifying existing obstacles and pitfalls (legal, organizational, etc.) and utilizing direct dialogue with the major agenda-setting entities of EU-Korea S&T Cooperation. The improvement of the framework shall lead to more effective collaboration of European and Korean research organizations, as well as the improvement of mutual understanding of the respective research systems in Europe and Korea.

Fig. 2: Information Day on 6th of October, 2010, in Seoul, Korea

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Publications

Policy Paper "Access opportunities for European researchers in Korean RTD programmes" (Jun. 2010)

Korean RTD programmes: Participation Guidelines for Europeans (Expected, Jan. 2011)

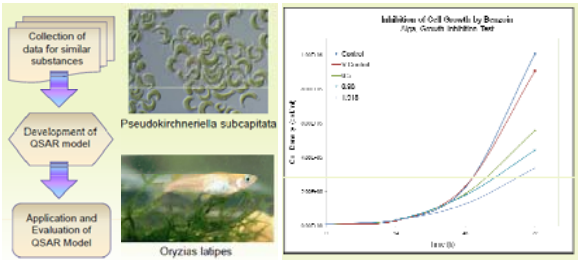
Computational methods in chemical risk assessment under new global chemical regulations

QSAR, Risk Assessment, REACH, Mixture toxicity

Recently, several new chemical regulations reforms were introduced worldwide. In Europe, the new regulation Registration, Evaluation, Authorisation and Restriction of Chemical Substances (REACH) was adopted. Companies attempting to fulfil REACH requirements were challenged with the limited available testing facilities and the increasing opposition to animal testing approaches. To overcome these challenges, non-testing (computational) approaches provide great assistance. In this area, we focus mainly on QSAR applications, exposure assessment and mixture toxicity prediction.

Non-testing approaches using Quantitative Structure-Activity Relationship (QSAR) models were strongly encouraged to predict substances' physico-chemical, environmental and toxicological properties in the context of the new European chemical regulation REACH. The extensive use of these methods to produce data for the purpose of fulfilling REACH registration requirements raises the question about the accuracy and reliability of the obtained results. To highlight this issue, an evaluation attempt of some non-testing models was conducted in one of our projects.

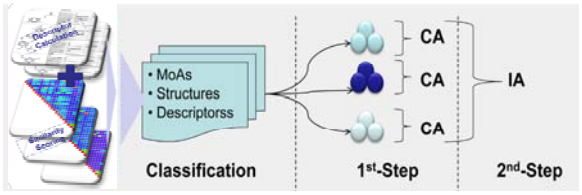
In our study, a cooperation attempt is conducted between conventional testing methods (applied according to OECD guidelines) and QSAR methods. Outputs from both concepts are compared and evaluated to assess the applicability of MLR QSAR methods in determining the ecological toxicity of benzoin.



Chemical mixture risk assessment for human health and the environment frequently focuses on single substances in conducting the risk characterization of chemical products and mixture. Nevertheless, living organisms including human beings are normally exposed to chemical mixtures rather than individual substances.

To overcome existing risk assessment methods, new concepts and techniques in computational toxicology are being attempted to predict the mixture toxicity. Advances in molecular biology and chemistry are combined with modelling and computational science to strengthen the predictive ability in this area of toxicology.

Our study is to evaluate the new application possibilities of the categorisation of mixture constituents using computerised analysis of chemical similarity as part of the prediction of mixture toxicity. The results show the potential that the categorisation of mixture constituents based on the computerised analysis on chemical similarity can be used to predict mixture toxicity effectively.



contact: Jongwoon Kim, jwkim@kist-europe.de

Acknowledgment:

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Publications

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Development of enYES (ENergY savings for homES) system

Energy monitoring and controlling system, sensor network, smart home

We have developed enYES, a prototype of energy management system for homes and building. enYES consists of two main components, wireless sensors as an instrument for energy consumption measurement and an intelligent home gateway as an energy consumption management portal. The intelligent gateway has a service of energy management, which provides a transparent interface across a heterogeneous network. enYES enables users to more efficiently manage energy consumption by monitoring and controlling electricity usage of each home appliance.

It has been well known that home and building have a significant energy saving potential compared with other sectors. For efficient energy savings, measurement, monitoring and control of energy consumption information are required. To this end, we have developed enYES, a prototype of energy management system, based on information and communication technologies for homes and buildings. In the developed prototype, wireless sensor was installed to measure the energy consumption and home gateway was integrated to monitor and manage the energy consumption.

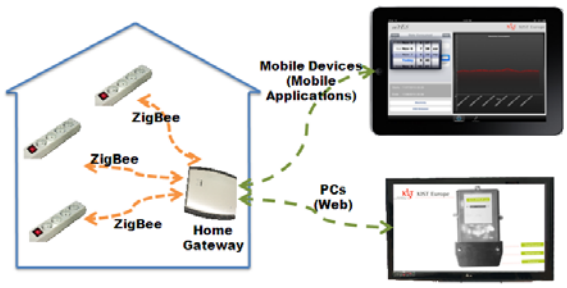

Fig. 1: enYES-energy management system

Wireless sensors are attached additionally in the conventional power taps, which means they are independent from electronic products. They have ZigBee or IEEE 802.15.4 network interface for communication. Because wireless sensor network is used in our system, the mobility of the nodes is higher than wired communication network. Also, our system could be installed without additional communication infrastructure. It has several services such as analyzing energy consumption, identification of inefficient appliances, and remote power control.

Wireless sensor has a ZigBee network interface for communication. It measures AC current and voltage information. It receives remote power control signal from an energy portal or an intelligent home gateway. Because it is attached in general power taps, it could be used with all of the house appliances.

Intelligent home gateway is a monitoring and management component of the prototype system, which is based on OSGi(Open Services Gateway initiative). It has various network interfaces like a conventional home gateway. Additionally, it has ZigBee network interface for energy consumption monitoring and management. All of the services are implemented on it.

Fig. 2: Exhibition at ICT for Sustainable Homes 2010

Fig. 1 shows the conceptual diagram of enYES. Wireless sensors in power taps are connected to an intelligent home gateway with ZigBee network interface. Home gateway as an energy portal provides a transparent interfaces to end-user. Easy and convenient user interfaces for different network devices is provided. For example, smart phones with network interface like Wi-Fi, and PC with Ethernet interface are supported. In order to disseminate our project results and introduce them to a broad audience, we presented enYES at the Exhibition, ICT for sustainable homes held in Nice, France, November 17-19, 2010 (see Fig 2).

Smart grid is a critical infrastructure of the future power system. For efficient electricity management, bidirectional information exchange is required between power companies and subscribers. enYES could be extended to a smart grid system. We expect that enYES is not only an energy saving system but also basic unit for smart grid integration in the future.

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Publications

Jongwoon Hwang, Woong Hee Kim “Energy management system based on wireless sensors and home gateway,” IT Service Conference, Seoul, 2010

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Anal Chem	2008	West, J. et al	126
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Nature Medicine	2007	Pipper, J. et al	36
Lab Chip	2007	Novak, L. et al	35
JAAS	2008	Jakuwoski, N. et al	26
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JAAS	2007	Venkatachalam, A. et al	19
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Anal Chem	2007	Chen, L. et al	12
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Thorax	2009	Westhoff, M. et al	10

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Nano Letters	2010	Neuzil, P. et al	10,0
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Lab Chip	2010	Neuzil, P. et al	6,3
Lab Chip	2010	Neuzil, P. et al	6,3
Lab Chip	2009	Salieb-Beugelaar, G. et al	6,3
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Biosens Bioelectron	2009	Kim, J.I. et al	5,4
Breast Cancer Res	2010	Baumbach, J.I. et al	5,3
Anal Chem	2010	Baumbach, J.I. et al	5,2
Anal Chem	2009	West, J. et al	5,2
Anal Chem	2010	Arora, A. et al	5,2
Anal Chem	2010	Salieb-Beugelaar, G. et al	5,2

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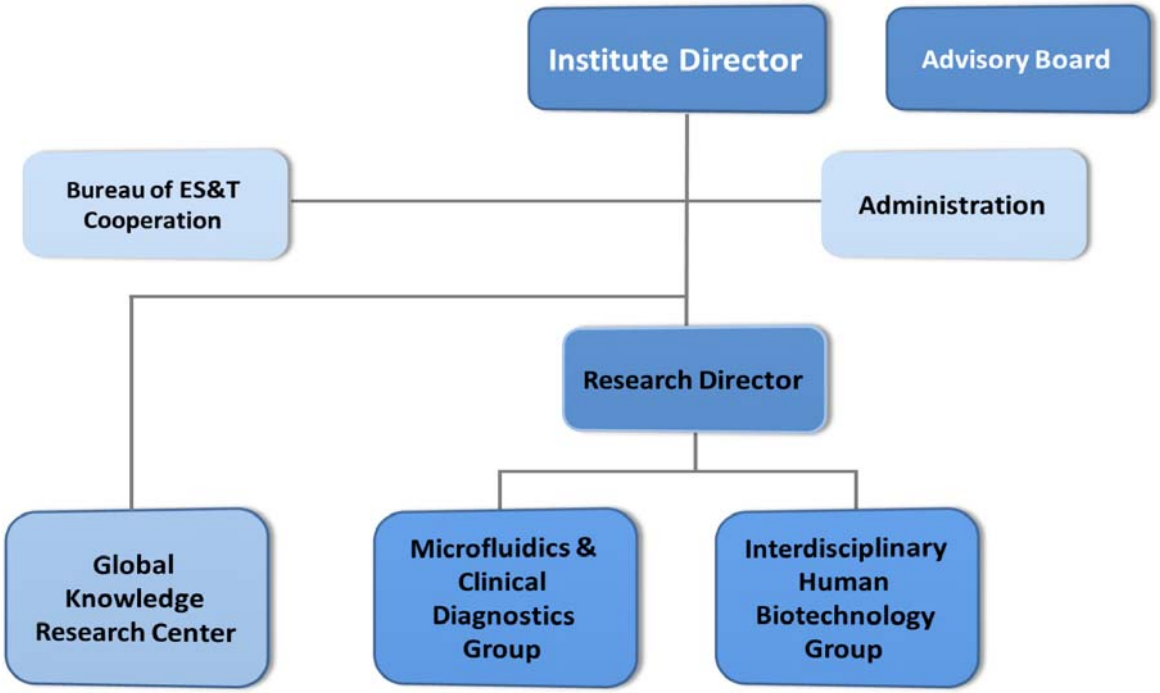

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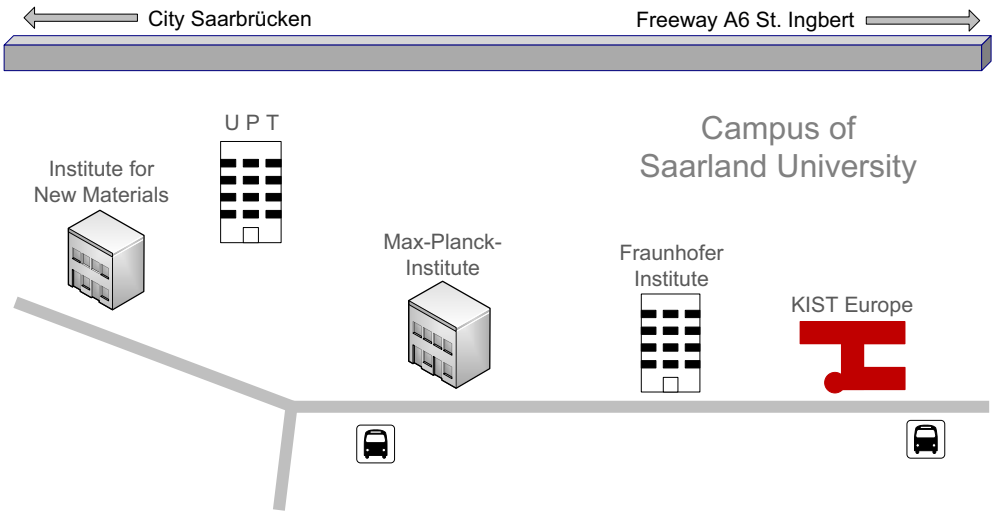

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By Car

Information for the navigation system:
66123 Saarbrücken, Stuhlsatzenhausweg 97

From east (Mannheim/Karlsruhe) to University: Freeway „A6 Mannheim-Paris“ up to the exit „St. Ingbert west“. From there, follow up to the sign of „Universität Ost“. Then finally you can find the main entrance of the university.

From north (Koblenz/Trier) to University: Freeway „A1“ to the interchange „Saarbruecken“, from there on „A8“ (direction to Karlsruhe) up to the freeway interchange „Neunkirchen“, from there on „A6“ (direction to Saarbruecken). That is the way to city center. In the city, you can find the sign "Universität Ost" easily.

From France to University: Freeway „Paris-Mannheim“ up to the exit „St. Ingbert West“, from there follow the sign-posting „Universität Ost“ up to the main entrance of the university.

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