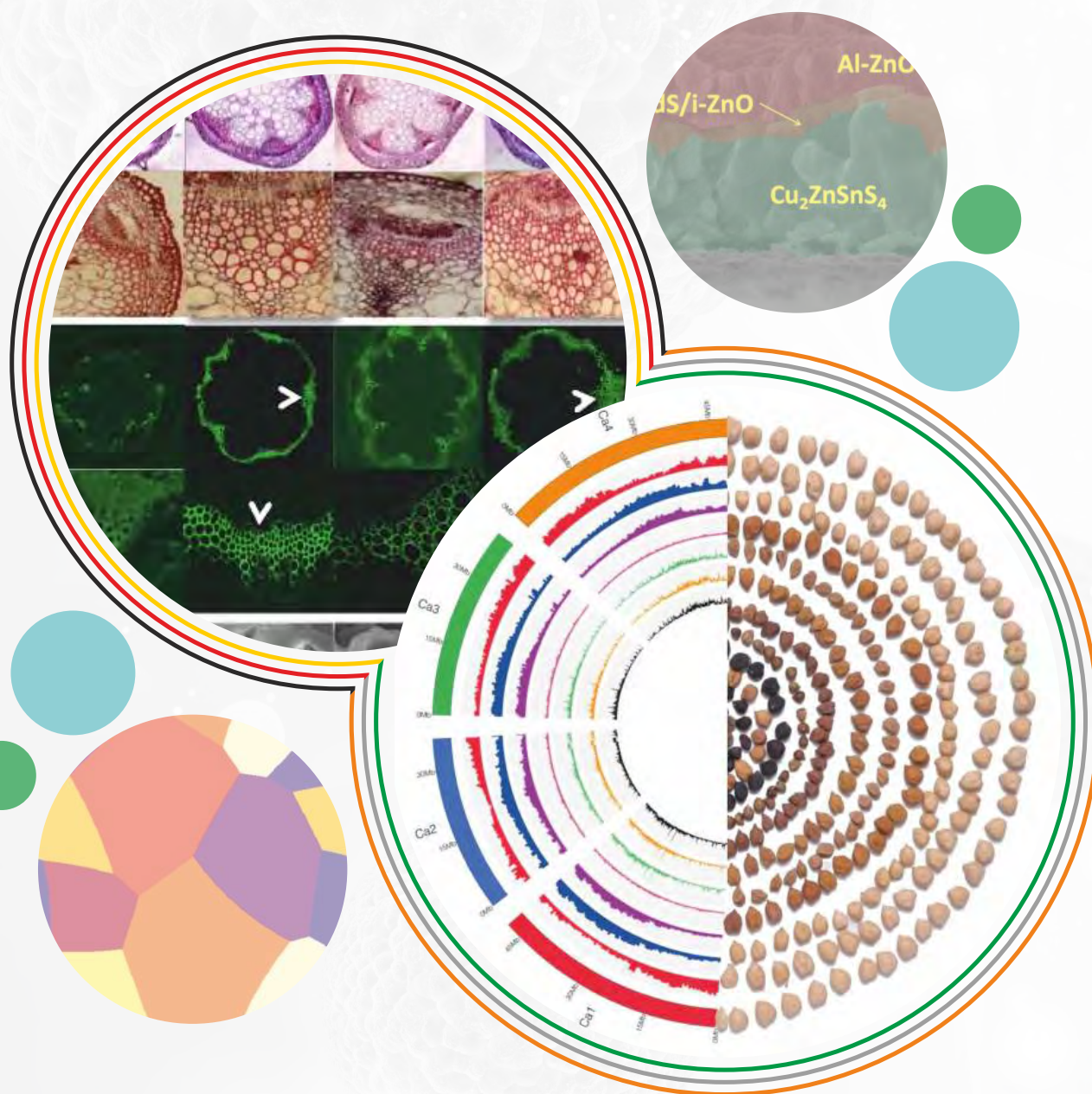
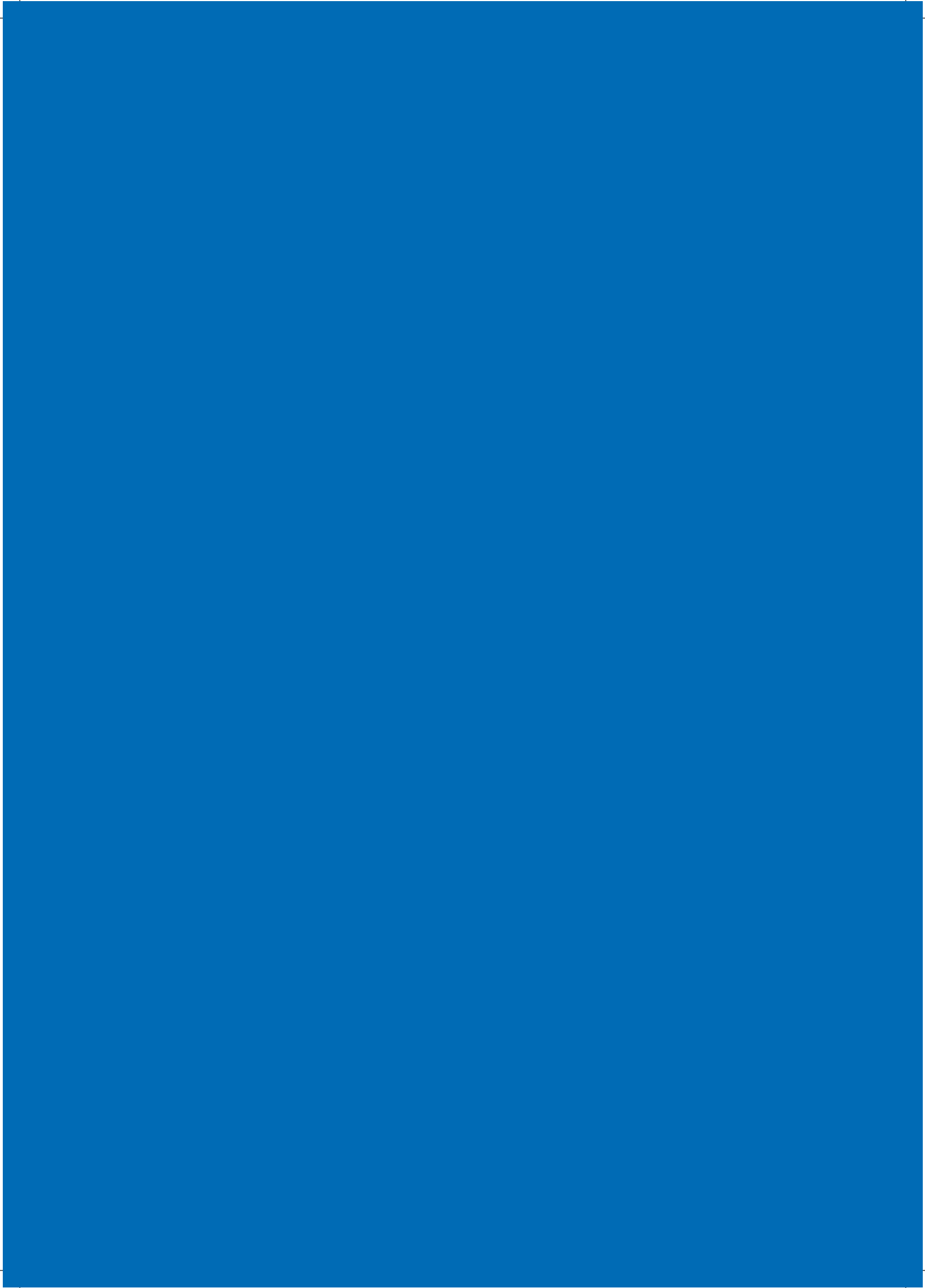
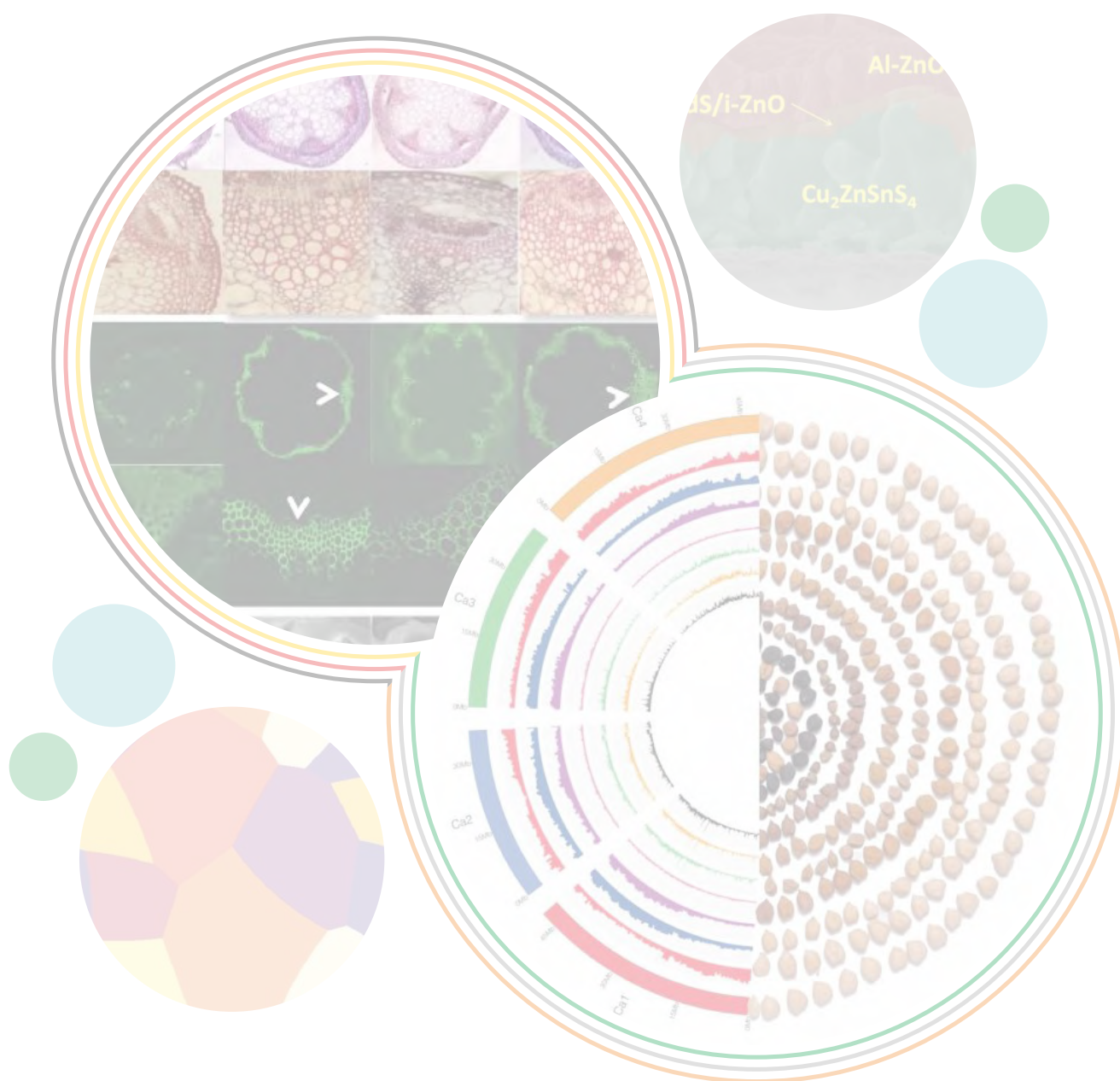


INDO-GERMAN SCIENCE & TECHNOLOGY CENTRE





INDO-GERMAN SCIENCE & TECHNOLOGY CENTRE



The Indo-German Science & Technology Centre (IGSTC) has been established to facilitate Indo-German R&D networking through substantive interactions among Government, academia/research systems and industry to foster innovation for the overall economic and societal developments of both the countries.

IGSTC aims to:

- ▶ Play a proactive role in facilitating participation of industry in joint R&D+I projects.
- ▶ Provide/assist in mobilizing resources to carry out industrial R&D+I projects.
- ▶ Promote electronic exchange and dissemination of information on opportunities in bilateral science & technology cooperation. The Centre will also prepare/ compile state-of-the-art reports on topics of interest with the help of highly qualified scientists and technologists from both the countries.
- ▶ Provide advice to institutes and industries from both the countries on the possibilities of Indo-German cooperation and help in the identification of suitable partners.
- ▶ Facilitate and promote Indo-German collaboration in science and technology through substantive interaction among Government, academia and industry.
- ▶ Encourage public-private partnerships (PPP) to foster elements of innovation and industrial application and cultivate a culture of cooperation between science and industry.
- ▶ Nurture networking between young and mid career scientists and technologists to develop a sense of mutual trust, leadership and entrepreneurship.
- ▶ Develop cooperation through the identification of scientists and scientific institutions of the two countries.
- ▶ Organize workshops, seminars, training programmes and other types of events on topics of mutual interest.

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FROM THE DIRECTOR'S DESK



At the outset, I would like to place on record my gratitude to Mr. A Chakraborty, on his remarkable service to IGSTC as its founding Director. The vast experience and expertise he brought has greatly helped IGSTC to survive during its infant phase and to grow further. His invaluable contributions have laid the foundations for a bright future for the partnership in generations to come and will be long and gratefully remembered.

IGSTC is now well recognized as a successful model and flagship initiative of Indo-German R&D partnership. The Centre has entered into its Second Phase in glory, with the joint declaration signed on 5th October 2015 between India's Ministry of Science and Technology and the Federal Ministry of Education and Research of Germany granting it an extension to 2022 and beyond. It also provides for doubling of its bilateral funding to 8 million Euros per year. On 2nd February 2016, Indian Prime Minister who chaired the Cabinet Meeting was apprised of the signing of the joint declaration at ministerial level. This enhanced funding will empower IGSTC to further strengthen and fortify research and technology collaboration of industrial relevance through cooperation between laboratories, academia and industries of both the countries.

IGSTC's well known 2+2 model projects, connecting academia and industry for translation of research results into products/processes and services, received widespread acceptance as a unique model of research partnership for socio-economic developments. During this period, IGSTC continued its support to 15 joint projects in emerging areas of (a) sustainable energy (b) advanced manufacturing (c) biomedical devices and biotechnology (d) water and wastewater technologies (e) nanotechnology and (f) embedded system and ICT, and 6 more projects are in the pipeline from the 2016 call. It makes IGSTC proud to mention that a network of more than 100 project partners representing academia and industry from both countries, where a total of 250 scientists, researchers, engineers are networked. The 2+2 Call 2017 is focusing on the overall thematic area - advanced manufacturing and new materials with subtopics: industry 4.0,

machine building, process technologies for new materials including nanomaterials, and light weight design and processes.

Counting upon my experience from Germany, different EU countries and India, I took over the leadership few months ago, and I am sure that scientific community as well as industry in both the countries will be strengthened through our programmes, ultimately translating the acquired innovation for the benefit of the society. With this vision, several new programmes are on the way. The previous annual workshop call is now restructured as an open call for workshops, making it a unique call aiming towards creating platforms for substantive interactions between scientists/researchers from academia and industry. Even though the focus is on the thematic areas of the 2+2 calls, other areas in the portfolio of both the ministries may also be considered.

Further, IGSTC is devising a new model of fellowship programme for the students and young faculty from India to have short stays in German industries/institutions. In this regard, we have reviewed the ongoing fellowship schemes between India and Germany ensuring that our programme is a standalone one. Another interesting programme could be the Indo-German Industrial and Academia R&D Network. This will provide the possibility to connect industrial and academic research labs in India and Germany, where funding will be provided for mobility.

It is also worthy to mention that IGSTC, which was struggling due to the long absence of a Director also witnessed internal changes. It has come out of the classical working style and has adopted a professional, system based and target oriented style – in short, its working model has now become truly Indo-German. The three Divisions – Scientific, Accounts and Administration are working independently, but synergistically contributing to each other. I would like to acknowledge all my colleagues, both in India and Germany for their hard work and contributions. At last and in fact importantly, the continued support from the Governing Body, DST and BMBF is acknowledged.

Roshan Paul

GOVERNING BODY



Arabinda Mitra
DST
Indian Co-Chair



Lothar Mennicken
BMBF
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CII



Clas Neumann
SAP

GOVERNANCE BODY

THE YEAR 2016-17 AT A GLANCE



IGSTC continued its support to 18 joint projects in 2+2 mode in emerging areas of (a) sustainable energy (b) advanced manufacturing (c) biomedical devices and biotechnology (d) water and wastewater technologies (e) nanotechnology and (f) embedded system and ICT during the year 2016-17. The total project investment (both Indian and German) can be estimated as INR 950 million or 12 million Euros and is involving 72 (seventy two) project partners from academia and industry from India/Germany.

In a yet another endeavor to promote Indo-German research partnership, IGSTC organised a symposium on “Smart Cities: Challenges & Opportunities” in association with FICCI (India), Nexus Institute (Germany) and PTV AG (Germany). The three day event from 27-29 April, 2016 included presentations, working groups panel discussions - “thematic roundtables”- and

The ‘Panel Discussions’ on various topics were informative, enthusiastic with the participants from diverse backgrounds bringing their expertise and experience working in the field of smart cities to the fore. The event had approximately 80 participants from India and Germany together.

Six projects approved from IGSTC Call 2015 in the thematic areas Water and Energy were awarded, releasing the first year grants to both institute and industry during the months July to September. The IGSTC Call 2016 for 2+2 grant applications in the overall thematic area “Smart Cities” with three subtopics: 1) integrated water management and sanitation system for urban settings, 2) energy efficiency in built environment and 3) technologies for the utilization of waste (waste to wealth generation technologies), launched in October 2016, received good response and the final results to be decided in the upcoming



field trips covering the areas of energy and buildings, mobility and management, waste management and sanitation, water, communication – safety – security in respect to Smart Cities. The focus of the symposium was on governance and integrative planning approaches. The event was graced by Indian and German academicians, scientists, industrialists and policy makers and was inaugurated by Parliamentary State Secretary Mr Thomas Rachel and the Indian Ambassador Mr Gurjit Singh commenting on the political strategies of both countries – especially the two initiatives “100 Smart Cities” and “Zukunftsstadt”.

Scientific Committee Meeting. The selection of projects is being done through a two step process to award project consortiums for possible funding.

During 2016-17, as IGSTC entered into its second phase, also witnessed a change in the leadership. IGSTC’s founding director, Mr A Chakraborty returned to his parent organisation CSIR after completing his deputation tenure in the end of April 2016. During August 2016, Mr Christian Joergens, German Co-Chair of IGSTC relinquished his duties and Dr Lothar Mennicken took over subsequently. Mr S S Sengupta, Manager (Accts and Admin) retired from the



position in August and Mr Sunil Kukreja joined as the new Manager subsequently. Dr Roshan Paul has assumed the leadership of IGSTC as its new Director on 1st December 2016.

IGSTC organized a Networking Event on 6th February at the German House, New Delhi to bid farewell to the previous management and to welcome the new leadership. Dr Arabinda Mitra, Indian Co-Chair, while welcoming the guests, briefed the importance of Indo-German scientific collaboration and IGSTC's growth as one of the flagship initiatives of Govt. of India and Govt. of Germany. He appreciated and thanked Mr Chakraborty for efficiently handling the IGSTC in its infant phase. Prof Ashutosh Sharma, Secretary, DST presented a memento to Mr Chakraborty for the exemplary work he has done as the founding Director of IGSTC. Prof Sharma also handed over a memento for former Manager Mr S S

Fabrik", the initiative of Prof Abele at TU Darmstadt. The aim of the "ETA-Fabrik" is the construction of a model factory, which unites several interdisciplinary approaches to reduce the energy consumption as well as the CO₂ emissions of industrial production processes.

IGSTC launched the first issue of its quarterly Newsletter covering the period January to March 2017 on 21st April 2017.

As a new programme, IGSTC intends to launch Open Call for Workshops to promote Indo-German bilateral networking among researchers and technologists in areas relevant to both the ministries (BMBF and DST).

IGSTC continued to shoulder the responsibility of implementation of the DST-Max Planck program on behalf of DST. This program has provided an excellent opportunity to the Indian young



Sengupta for his invaluable contributions to IGSTC. Prof. Sharma and Dr Mitra introduced the new director, Dr Paul and the new Manager Mr Kukreja to the gathering.

The 2nd Finance Committee Meeting and the 8th Governing Board Meeting of IGSTC were held on 15-17 March 2017 in Mühlthal, Germany. The GB deliberated in detail on several matters with decisions and suggestions on possible new initiatives/programmes. It also discussed possible thematic areas for the upcoming 2+2 Grant Calls, Workshop Calls and new programmes.

After the GB meeting, participants visited "ETA-

scientists to partner with the global leaders at the Max Planck Institutes in Germany through a networked model of cooperation. IGSTC has been administering 15 Partner Groups at newly established IISERs, IITs and Central Universities. As some of them already completed their project term, currently IGSTC is handling only 10 Partner groups. There are 19 ongoing Max Planck-India Visiting Fellowships (Mobility Grants) granted to young researchers from various universities / research institutes.

A detailed report on various activities is presented in the following pages.



PROGRAMME ACTIVITIES

2+2 PROJECTS

AMPLAST

Advanced manufacturing process monitoring using in-line laser thermography

Objectives

- Development of a quantitative, rapid and non-destructive laser thermographic testing technique for the in-line manufacturing process monitoring that can withstand difficult processing environments and make reliable measurements that can add value to industries
- Development of Laser-thermographic testing method for the detection of surface cracks at hostile environmental conditions as found in industrial steel production
- Evaluation and characterization of the crack detection method
- Optimization and characterization of the crack detection method
- Optimization of the crack detection schemes (analysis algorithm, on-line capability)
- Implementation of an on-site testing system; validation under industrial production environments (field study)
- Development, validation and optimization of theoretical models and simulation themes for an enhanced understanding of the method
- Development and evaluation of a Lab system allowing anisotropy measurements, accompanied by theoretical modelling and simulations for a validation of the experimental results

Progress made/achieved

- Laser-thermographic testing setup was established and characterized allowing measurements under controlled conditions which match realistic production environments
- First experiments prove the general operability of the concept and allow preliminary estimations on performance and reliability
- Algorithms for analyzing the acquired data were developed and tested
- FEM simulations were established for a comparison and evaluation of the experimental results
- A set of experimental data was acquired for a parametric evaluation of the method

Specific Objectives

Development of the laboratory based experimental apparatus BAM-Design of the experimental setup for crack detection at elevated temperature

An experimental laboratory developed for high temperature laser thermographic experiment. Status of the laboratory set up developed at BAM is described below.

Induction source (5 kW) integrated into setup: $T_{\max} \sim 600-700^{\circ}\text{C}$	Shielding sandwich against EM-field and conduction heat transfer	500 W laser line (940 nm, moving/fixed)
High-Temp calibration of IR camera	Sample on translation stage, moves through laser line ("real situation")	Max. speed 100 mm/s (sample motion)
Heating, movement and testing are automated		Housing with built in water bassin

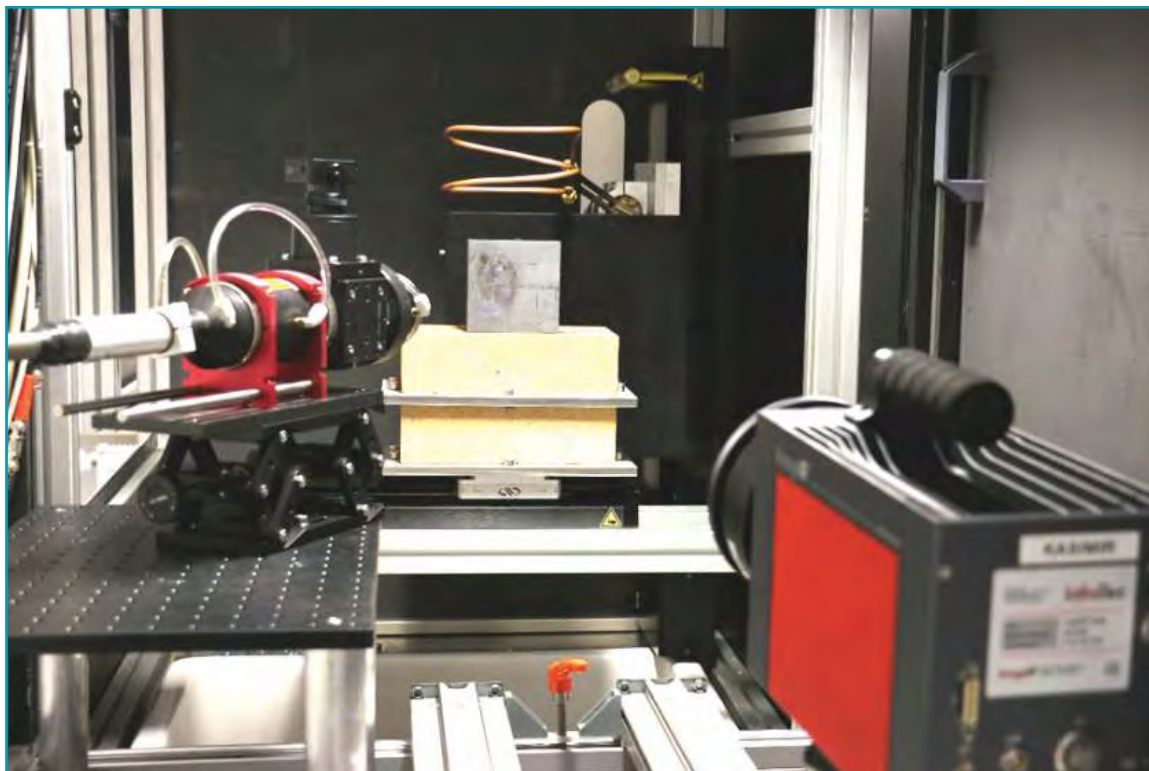


Fig. Experimental setup. After the sample is heated by the induction heating it moves on a linear stage through the field of view of the IR-camera. At the same time the laser locally heats the sample surface.

Development and validation of the models for improved understanding

IITM- 3D finite element modeling for crack detection using laser thermography

In order to understand the localized laser heating and its interaction with a crack, finite element based numerical models were developed. The model solves the heat diffusion phenomena in the 3D geometry. The CW laser scanning is modeled using a surface Gaussian heat source as boundary condition. The convection and radiation phenomena were also considered in the present model. The thermo-physical properties of the material were considered as temperature dependent (Thermal conductivity, specific heat capacity and density). 2D laser scanning carried out across the crack whereas the initial temperature of the steel block was set to room temperature. The simulation done for different surface temperature (300K, 400K, 500K, 600K)

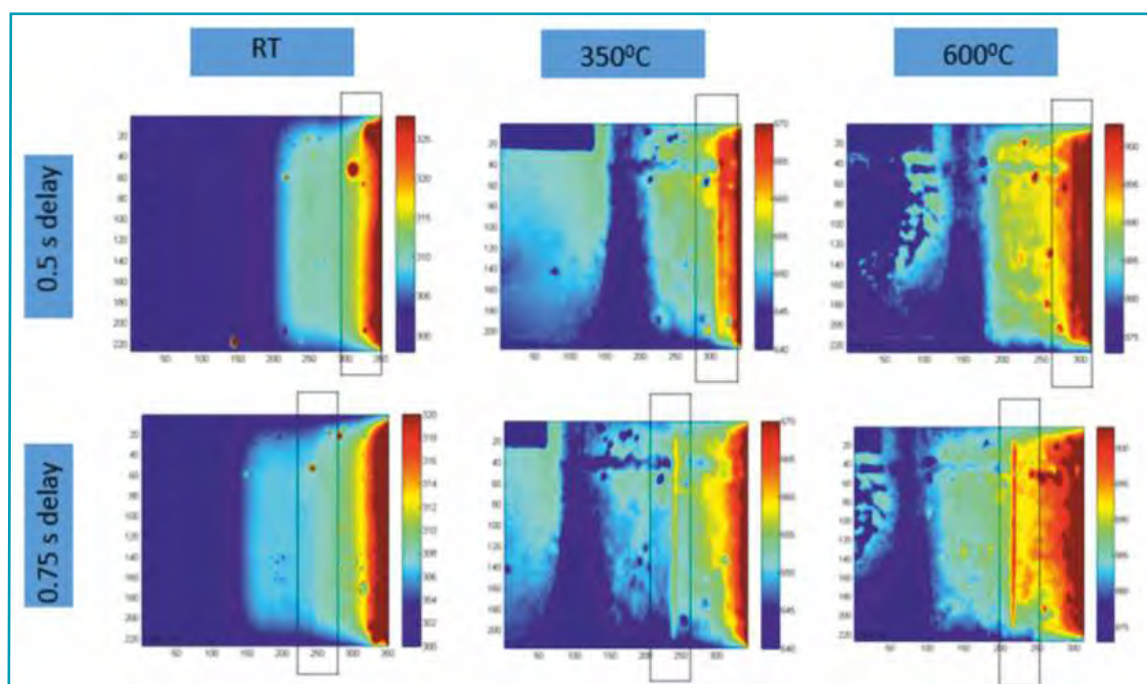


Fig. Processed image at various time delay and surface temperature thermography

Publications

Journal Publications

- CM Basheer, CV Krishnamurthy, K Balasubramaniam, Hot-rod thermography for in-plane thermal diffusivity measurement, Measurement 103, 235-240, 2017
- CM Basheer, CV Krishnamurthy, K Balasubramaniam, Hot-rod thermography for defect detection, Non-Destructive Testing and Condition Monitoring (The Journal of The British Institute of Non-Destructive Testing) (Accepted)

Conference papers

- P. Myrach, B. Polomski, E. Le Claire, S. Unnikrishnakurup, Nithin Vengara, K. Balasubramaniam, M. Ziegler; "Thermographic Crack Detection in Hot Steel Surfaces", Conf. Proc. WCNDT2016, (2016)

- P. V. Nithin, U.Sreedhar, C. V. Krishnamurthy, M. Zeigler, P. Myrach and K. Balasubramaniam; “In-line Laser Thermography for Crack Detection: A Numerical Approach”, Quantitative Infrared Thermography Conference QIRT-Asia, Mahabalipuram, India, July 6-10, (2015)
- Nithin Puthiyaveetil, SruthiKrishna, RenilKidangan,SreedharUnnikrishnakurup, C V Krishnamurthy, Mathias Zeigler, Philipp Myrach and Krishnan Balasubramaniam; “ In-line laser thermography for crack detection at elevated temperature: A Numerical modelling study”, Quantitative Infrared Thermography Conference QIRT Gdańsk , Poland, July 4-8, (2016)
- Nithin Puthiyaveetil,Renil Kidangan,Sreedhar Unnikrishnakurup, C V Krishnamurthy, Mathias Zeigler, P. Myrach, K. Balasubramaniam: “In-line laser thermography for fast detection of defects at elevated temperature”, Non-Destructive Evaluation 2016, Thiruvananthapuram, India, Dec 15th to 17th 2016



AMPLAST



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Dresden



FEC-ONLINE

Online-indication of pathogen-like pollution in water by fecal pigment (FP) analysis

Objectives

The primary objective of the project is to develop an instrument based on fluorescence for detection and estimation of fecal pigments: urobilin (UB) and stercobilin (SB)

The detailed objectives are as follows:

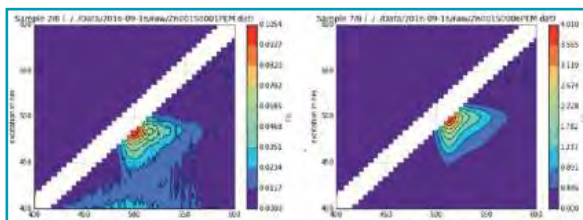
- Understanding and optimizing zinc ion based fluorescence enhancing reagent for FP
- Design of an new analytical unit consisting of automatic reagent-mixer / preconcentration unit which can be directly coupled to a suitable fluorescence detection device
- Software for identification and quantification of FP in water using fluorescence
- Prototype of pre-concentration unit for field conditions
- Evaluation of the whole unit

Progress made/achieved

During the last one year, the German Academic Partner (TZW) focussed its activity in three directions: (i) Design of the standard operational procedure (SOP) for FP- analysis in water of different origin by native fluorescence and LC-MS/MS; (ii) beginning of a measurement program of real waters and transfer of the SOP to the Indian Industrial Partner (Spectro) including the organization of reference measurements; and (iii) optimizing the solid phase extraction conditions for FP.

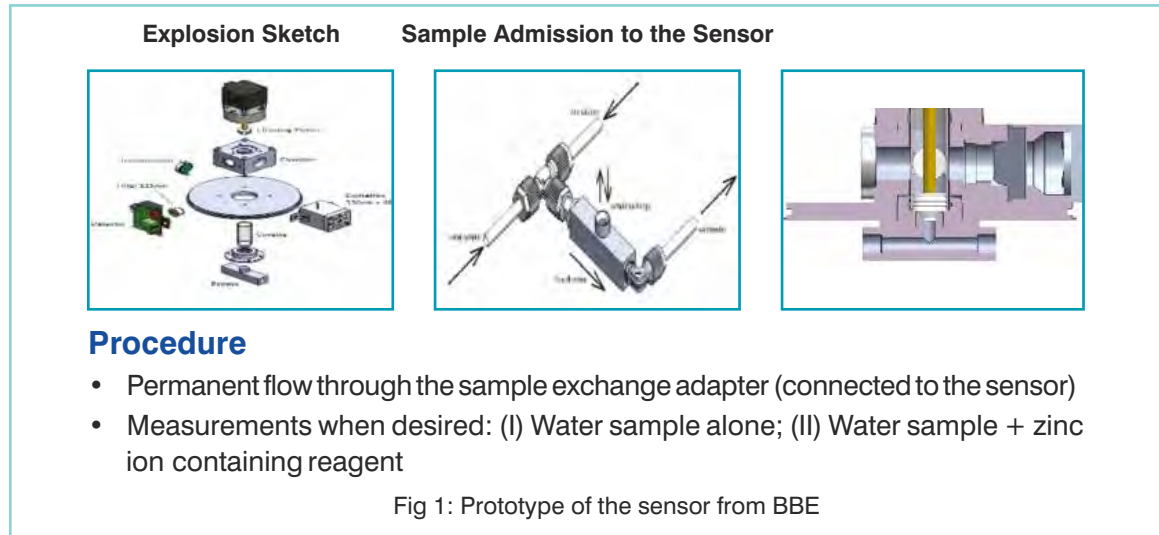
During the same period the Indian Academic Partner (IITM) was engaged in (i) calibration of FP in water, (ii) understanding the photo physical origin of the fluorescence of SB-Zn and UB-Zn complexes; (iii) looking for a method to minimize/eliminate time dependent loss of fluorescence intensity of the complexes; (iv) looking for conditions for further enhancement of fluorescence intensity of the complexes; and (v) working towards developing a reagent cocktail for enhancement of FP fluorescence.

The main activities of the Indian Industrial Partner (Spectro) has been towards installation of the analytical procedure (LC-MSMS) for determination of pigments in water bodies, in close collaboration with TZW.



The German Industrial partner (BBE) has been working on sensor design and transfer of suitable technique for improvement of fluorescence sensitivity in field conditions. Figure 1 shows the design studies of the prototype of the sensor. The central segments

are the LED's which covers the excitation spectrum of the fecal pigments and the photomultiplier which are used for detection of the fluorescence. The field modus of the device is guaranteed by "stop-and-flow" –technique.



Meetings/Conferences/Networking Events

Two Consortium meetings have been held so far: the first consortium meeting (kick off meeting) on October-2016 at Kiel, Germany that decided the project objectives and the second one on February-2017 at IIT Madras, Chennai, India, that reviewed the initial research by the four partners. A third one is planned at Dresden from 27th August to 2nd September 2017.

Conference attended

One conference was attended by Swayam Prakash (Research scholar) namely International Conference on Sophisticated Instruments in Modern Research 2017 (ICSIMR-2017) held at IIT Guwahati on 30th June 2017. He also got best poster award in ICSIMR-2017.

Project related personnel exchange

An undergraduate student from TZW, Ms Rebecca Paulina Dorner, carried out her undergraduate project at IITM during 1 April - 30 June, 2017.

Improvement of sensitivity in the determination of faecal pigments in hard water by means of fluorescence spectroscopy.



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IIT Madras
Chennai



Pragati Yadav
Spectro Analytical Labs. Ltd
New Delhi



Wido Schmidt
DVGW Technologiezentrum Wasser
Karlsruhe



Christian Moldaenke
bbe Moldaenke
Schwentinental



CANDECT

Cluster-composite nanofibre membranes for rapid, ultra-trace detection of waterborne contaminants

Objectives

Dissolved water contaminants of inorganic (arsenic, chromate, fluoride, uranium, nitrate or strontium) and organic (pesticides, plasticizers, pharmaceuticals, alkylphenols, endocrine disrupters) origin play an important role in drinking water quality and health. Water guideline values are usually in the ppb ($\mu\text{g/L}$) region, which makes detection difficult. Monitoring of such contaminants is time consuming and expensive which poses a significant challenge especially for water supplies in rural areas and/or in developing countries, which present a vast, hugely unexplored and scientifically challenging market. The development of suitable sensor technologies using advanced materials that can be integrated to hand-operated pumps or decentralized water supplies is the subject of this proposal. The materials will interact with pollutants by covalent, supramolecular or ionic interactions and the detection will subsequently take place by excitation and read-out of the colorimetric signal via commonly available devices such as i-phones. Atomically precise clusters with specific interactions with inorganic and organic contaminants developed by IIT Madras for the detection of heavy metal ions in water at ultra trace levels will be incorporated in electrospun fibres and porous substrates. This technology will be developed further into a sensor device for arsenic in drinking water. Simultaneously the same technology will be expanded further to address specific challenges of chromate, fluoride, a select number of pesticides and alkylphenols (for example) for proof of concept.

Progress made/achieved

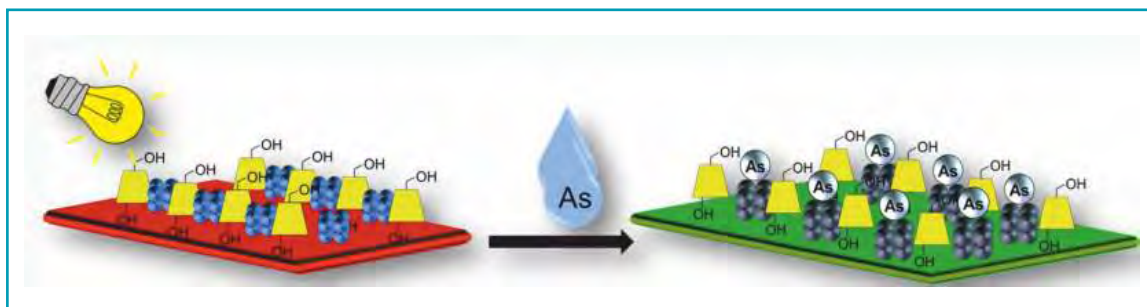
Major Activities

1. Cluster system material development (As)
2. Composite fibre eletrospinning polymer selection & methodology development
3. Cluster system material development (Cr, F)
4. Device design & integration (LED excitation and read-out)
5. Cluster system material development (Pesticides and Alkylphenols)
6. Cluster characterization (surface spectroscopy, luminescence response, interference) & cluster redesign (if required)
7. Development of composite fibre membranes (electrospinning, support membrane choice, cluster immobilization in polymer membrane)
8. Sensor mat characterization (spectroscopy, electron microscopy, surface functionality)

Key outcomes and achievements

- **IIT:** A suitable cluster system is being developed to study detection of contaminants in water. The complete characterization of the cluster system has been done with the facilities mentioned above. Suitable polymer for making electrospun fiber mats/membranes has been chosen and all the spinning parameters have been thoroughly optimized. Uniformity of fibers has been checked by the appropriate characterization techniques. The methodology for cluster immobilization on the fiber surface has been established and the luminescence studies are under progress.
- **KIT:** The method for determining the arsenic interaction with cluster has been set up as Fluorescence response as a key parameter to monitor the arsenic-cluster interaction. Characterization and modification of cluster systems will be carried out using the methods set up so far.

A suitable GC-MS system was identified, tested and purchased in the first project period. This was delivered in May 2017 with the intention to set up pesticide analysis for the later stage of this project. Methods to identify pesticide interactions with polymer fibres exist in the KIT laboratory.



Cluster immobilized luminescent electrospun fiber
Membrane containing organic scavengers

Colorimetric sensing by the fiber membrane upon
exposure to Arsenic contaminated water



Thalappil Pradeep
IIT Madras
Chennai



Anshup
Inno Nano Research Pvt Ltd (INR)
Chennai



Andrea Iris Schäfer
Karlsruhe Institute of Technology (KIT)
Karlsruhe



Hansjörg Fader
Fader Umwelttechnik (FAD)
Karlsruhe



DNDHCSA

Design and development of hollow crankshaft for automobiles

Objectives

The awareness of climate change and the limited availability of resources also lead to reconsideration of the resources used in heavy weight vehicle production. As often the raw material costs are considerably higher than the labour costs, in addition to previous factors, new, resource-efficient factors of competition will decide about the success of a company in the future. Thus, the prices for resources and especially their availability or accessibility will gain more and more importance. Therefore, sustainable action starts with sustainable production. For this reason, the drivers for progress and innovations in production technology are completed by another topic: resource efficiency. Strategies and approaches leading to efficient use of resources are, e.g. methods for increasing the process stability, the application of efficient technologies, the use of efficient production plants or the optimization of process chains by process integration and combinations. However, not only product manufacturing can be optimized in terms of resource efficiency using such strategies. There is also the opportunity to achieve corresponding savings in resources in the operation of the product, i.e. during vehicle (truck or tractor) operation. Thus, the consistent use of strategies for lightweight construction in conventional vehicles making leads to a reduction in fuel consumption and also to a reduction in CO₂ emissions.

Considering these aspects, the objective of the planned project is the development of a new, innovative design for lightweight crankshafts segments which offers additional potentials concerning the reduction of the resources used for part manufacturing. Additionally, real prototype segments will be realized by appropriate manufacturing technologies. With the help of the test cycle investigations, achievable effects regarding lightweight design increase of manufacturing efficiency, cost minimization etc. can be proved and further potentials will be estimated. Since the production requirements and conditions (e.g. part numbers, part variants, manufacturing equipment, etc.) will be considered, scalable and re-configurable processes and process chains can be identified to guarantee the later optimum crankshaft manufacturing at OEMs or suppliers regarding lightweight design and manufacturing costs.

Progress made/achieved

Specific Objectives

In the third period of the project further Finite Element Analyses of hollow crank shaft segments were made. Residual stresses due to the welding process were realized by the Finite Element Simulation on the crankshaft model using Goldak's double ellipsoidal heat source model.

Sequential thermal and mechanical analysis has been carried out to approximate the weld residual stresses. Transient thermal analysis for a duration of 370 s (189 s for moving the heat source and remaining time for cooling purpose) has been performed. The temperature profile at 370 s of simulation time and the corresponding residual stresses distribution are depicted in the Fig. 1.

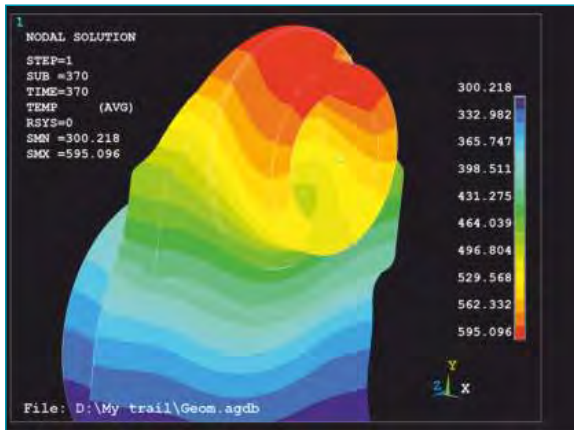


Fig. 1-1

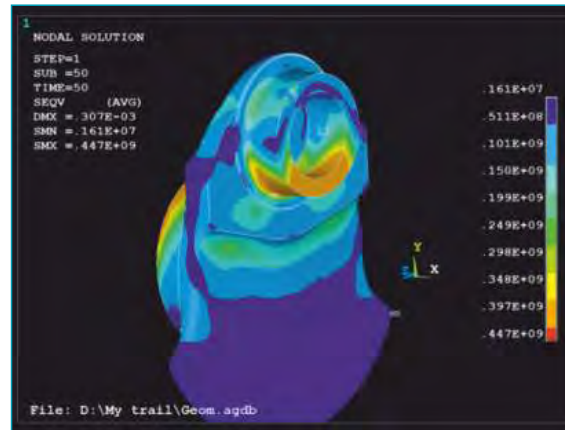


Fig. 1-2

Fig.1: Thermo-Mechanical Simulation; Temp Profile left and stresses right [CSIR-CMERI]

In Fig. 2 you can see the modal analyses for two-segment model which was made by partner CSIR-CMERI to show the deformation during operation using different frequency modes.

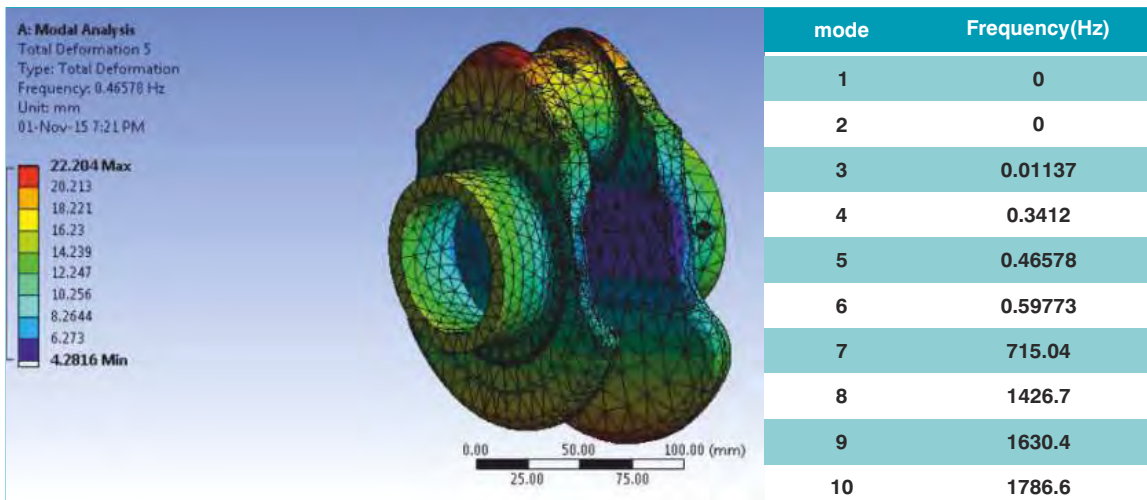


Fig. 2: Model analysis for hollow crank shifts [CSIR - CMERI]

Because of modified geometrical details (pin and journal wall thickness, bores and modified counter weights), further Finite Element Analysis were carried out and the final crankshaft geometrical design was determined by partner Bharat Forge Ltd. (BFL). Optimizing various geometrical parameters of crankshaft, the weight reduction (around 25%) is achieved without compromising its strength and stiffness. The finalized lightweight geometrical design was analysed against various crankshaft design criteria like bending and torsional stresses, bending and torsional rigidities, bearing reactions, balancing, deflection in bending etc.

In Fig. 3 you can see the comparison of bending rigidity of initial solid 1-cylinder segment and final hollow 1-cylinder segment. In Fig. 4 you can see the comparison of torsion rigidity of initial solid 1-cylinder segment and final hollow 1-cylinder segment.

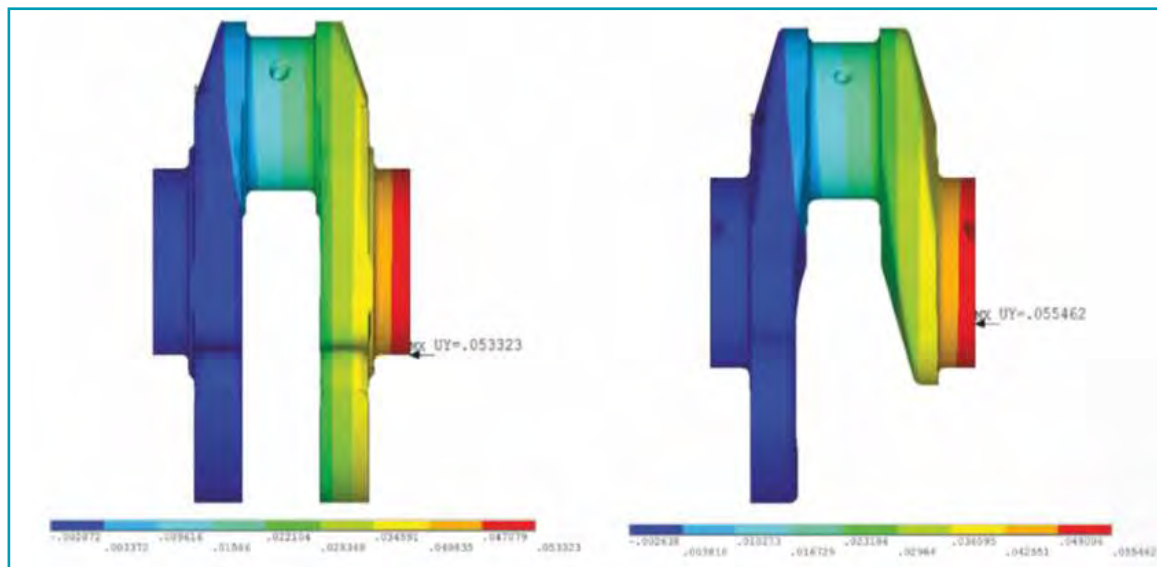


Fig. 3

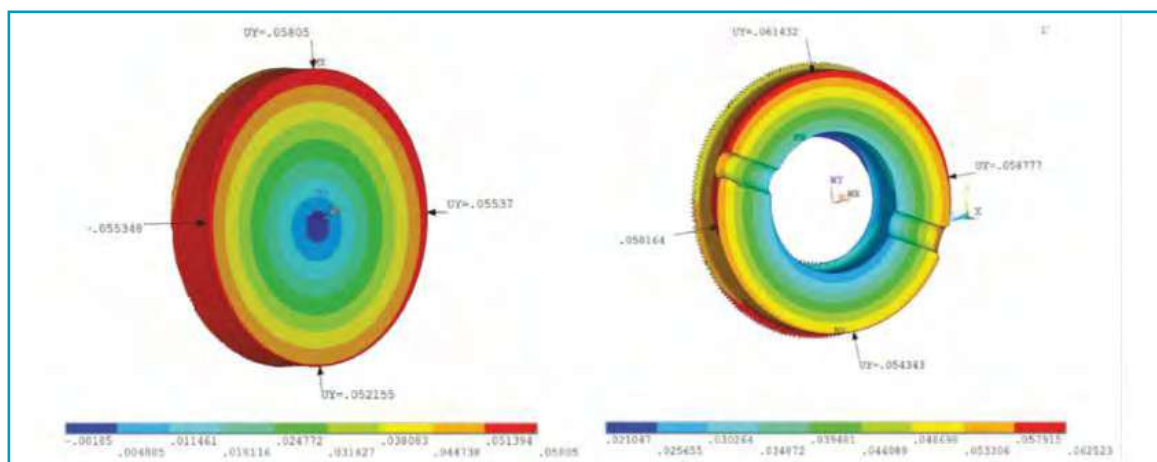


Fig. 4

Using cutting technologies to prepare hollow rod bearing dummies and electron beam welding (EBW) technology to realize 1-cylinder dummies out of selected material, the second series of test specimen with wall thickness 14.5 mm (with relevance to final crank shaft design) could be manufactured. Hollow specimens with radial boreholes for torsion tests and hollow specimens without radial borehole for bending tests were sent to BFL by partner Fraunhofer (see Fig. 5).

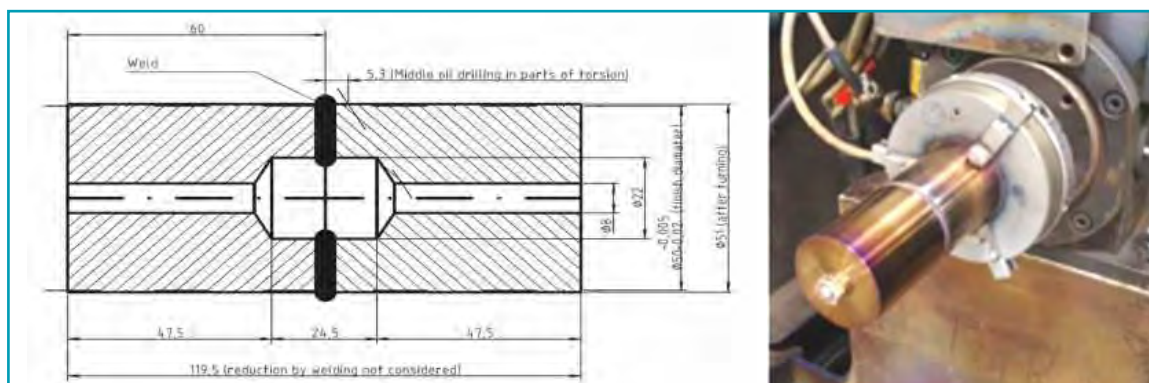


Fig. 5: Hollow rod bearing specimen for EBW - Wall thickness 14.5 mm [Fraunhofer]

For further Finite Element Analysis of EBW process at partner CSIR-CMERI, the operating data for welding process of second series could be handed by partner Fraunhofer (see Fig. 6). The testing of specimens, bending and torsion fatigue testing is running on the test rig. The results of this will help in comparing with the results of prototype fatigue testing and further optimization to the design based on the comparison. Along with fatigue testing the engine testing of full hollow crankshaft prototype is also planned by partner BFL.

Process in 5 Steps: (1) Pre-heating (2) Tracking (3) Welding (4) Smoothing (5) Post-heating				
EBM				
(1) Pre-heating: + Standard Furnace + 250 °C(1 - 2 h)				
(2-4) EBM: + welding Diameter 51 mm + slop in 10 mm + overlapping 5 mm + slop out 20 mm (250) + weld Seam length 180.22 mm + weight 1.78 kg + spec. heat capacity 490 J/kg/K + efficiency 97% + voltage 60 kv				
(2) Tacking: + amperage 20 mA + power 1.2 kW + speed 30 m/s + energy input 7.21 kJ + heating 8 K	(3) Welding: + amperage 80 mA + power 4.8 kw + speed 15 m/s + energy inputs 57.67 kJ + heating 64 K	(4) Smoothing: + amperage 30 mA + power 1.8 kw + speed 15 m/s + energy inputs 21.63 kJ + heating 24 K	(5) Post-Heating: + standard furnace + 600 °C(1 - 2 h) + Cooling to room temperature (switch off furnace)	

Fig. 6: EBW process parameter and square section of welded specimen; Wall thickness 14.5 mm [Fraunhofer]

After final definition of segmentation for forging process, three separate geometries and two turning parts at left and right end were defined by partner Fraunhofer (see Fig. 7). In parallel partner Seidel started purchase and pre-machining of forging die material.

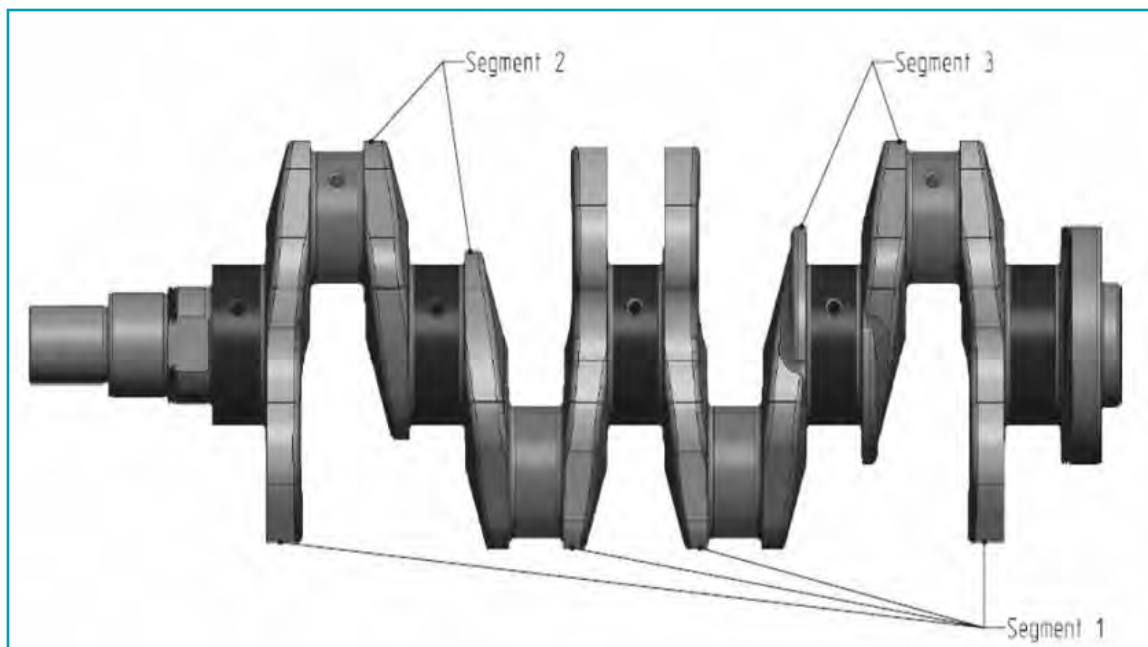


Fig. 7: Segmentation of final hollow crank shaft [BFL/Fraunhofer]

Key outcomes and other achievements:

The material selection for hollow crankshaft was done based on several different manufacturing processes (forging, machining and welding) and different involved and required metallurgical parameters. Micro-alloyed steel was found as suitable, because it contains micro-alloying elements which precipitates at higher temperature and restricts uneven grain growth. The resulting grain structure achieved in finely distributed grains without external heat treatments. This resulted into better mechanical and fatigue properties.

In addition the forging die design for hollow crankshaft prototype segments as final step for further geometry definition was made by superposition of all three segment types. By acceptance of intermediate cutting processes, which will be done by partners IWU and Seidel, all segments will be forged with same die geometry (see Fig. 8).

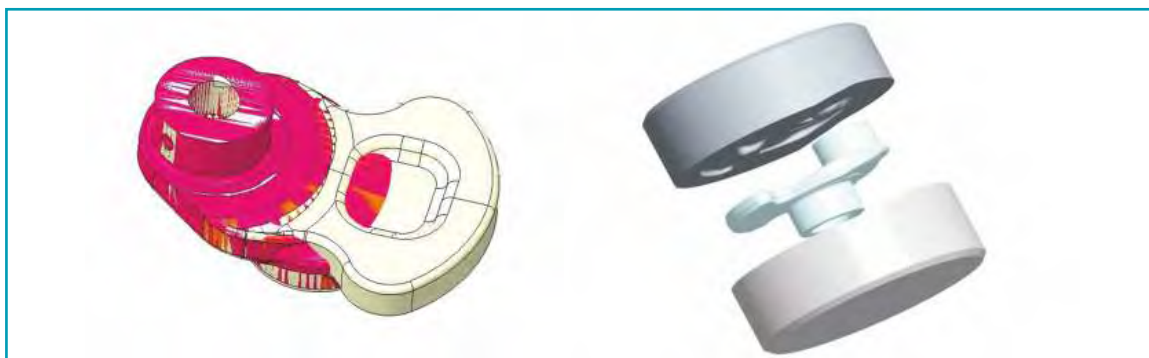


Fig. 8: Superposition of all three segment types to one master segment [fraunhofer] and tool making principle [Seidel]

General Public Relation activities

- At Bangalore “IMTEX Forming 2016” in connection with project discussions the keynote address titled: “Vehicle Light-Weighting” was held at seminar: “Shaping the future of Manufacturing”. Members of Fraunhofer, BFL and CMERI joined the conference.
- Annual event of IGSTC 2016 held at New Delhi – BFL& CMERI presented technical poster on project

	Naresh Chandra Murmu CSIR- CMERI Durgapur	
	Rajkumar P Singh Bharat Forge Ltd Pune	BHARAT FORGE 
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DP-FORGE

Combined process and alloy design of a micro-alloyed DP forging steel based on integrative computational materials engineering

Objectives

This project aims the development of an energy efficient production of forged components (eg gears) from microalloyed dual phase steel with reduced distortion. The material and production design will be realized by means of a generic ICME framework. The scientific approach is based on integrative numerical material and process simulation spanning over length scale from nanometer up to component scale of centimeters and taking into account all relevant process steps including hot forming, annealing and local final material properties in component in application. In recent years, higher strength in these gears has been strongly desired from the viewpoints of weight reduction and downsizing. In automotive applications, heat-treatment distortion of gears has also become a problem due to demand for reduced noise. This project aims to also illustrate the emerging ICME paradigm that is giving a digital push to the materials engineering domain.

Expected deliverables

- Numerical design of alloy composition
- Experiments on thermomechanical process simulation
- Microstructural phase and grain size characterization
- Precipitation characterization
- Precipitation modelling on Nano scale during hot forming
- Microstructure evolution modelling during thermomechanical processing
- Microstructure transformation modelling during cooling
- Model implementation and parallelization
- Link of models
- Multiscale modelling of hot forming process chain
- Benchmark and validation trials
- Management and reporting

Progress made/achieved

Numerical design of alloy composition

An alloy was designed using a combinatorial scheme that involves querying the steel databases from the softwares ThermoCalc and Pandat and an optimal alloy design criteria to suite the requirements for the DP steel gear. Apart from the phase diagram requirements, machinability was also considered during this process.

ICME implementation

The ICME workflow, focusing on vertical integration was implemented for microscale and above as shown in figure 2.

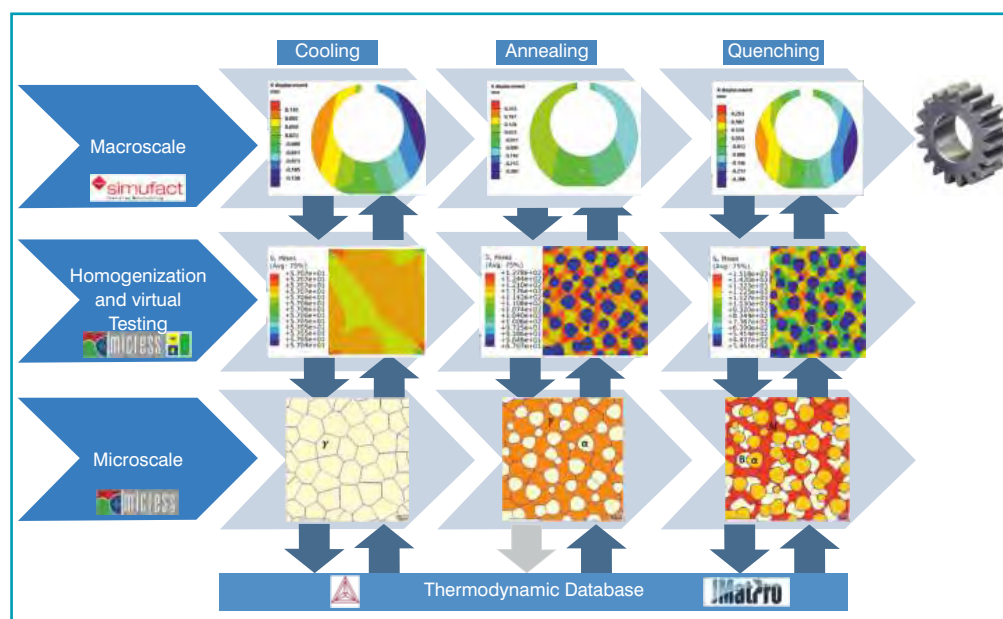


Fig. 2: ICME workflow achieved

Publications

Peer reviewed conference papers

- Deepu Mathew John, Hamidreza Farivar, Gerald Rothenbucher, Ranjeet Kumar, Pramod Zagade, Danish Khan, Aravind Babu, BP Gautham, Ralph Bernhardt, G. Phanikumar, Ulrich Prah. An attempt to integrate software tools at microscale and above towards an ICME approach for heat treatment of a DP steel gear with reduced distortion, Proceedings of the 4th World Congress on Integrated Computational Materials Engineering (ICME 2017), pp 3-13 (DOI: 10.1007/978-3-319-57864-4_1)
- M.J. Deepu, H. Farivar, U. Prah, G. Phanikumar. Microstructure based simulations for prediction of flow curves and selection of process parameters for inter-critical annealing in DP steel, IOP Conference Series: Materials Science and Engineering, Volume 192, conference 1 (DOI: 10.1088/1757-899X/192/1/012010)
- Hamidreza Farivar, Gerald Rothenbucher, Ulrich Prah, Ralph Bernhardt. ICME-Based Process and Alloy Design for Vacuum Carburized Steel Components with High Potential of Reduced Distortion, TMS ICME 2017 to be held in Michigan, USA from 21st to 25th May, 2017

Conference Presentations

- An attempt to integrate software tools at microscale and above towards an ICME approach for heat treatment of a DP steel gear with reduced distortion, 4th World Congress on Integrated Computational Materials Engineering (ICME 2017), Ypsilanti, Michigan, USA. (21-25 May, 2017)

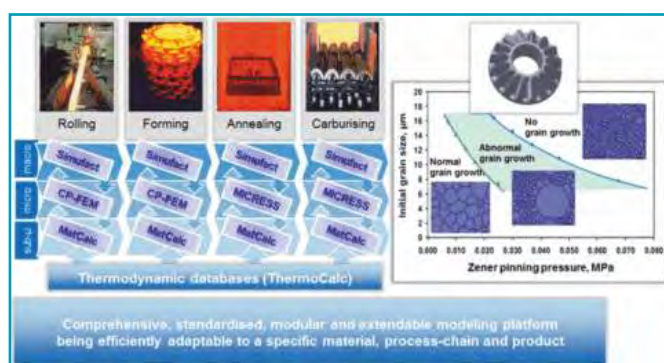
- A study on the effect of incorporation of microstructure information on macroscale finite element simulation of inter-critical annealing in Dual Phase Steel, Material Science and Engineering (MSE) Congress 2016, TU Darmstadt, Germany. (27-29 September, 2016)
- An ICME approach towards the design of a new gear steel with reduced distortion, Heat Treatment and Surface Engineering (HT&SE) conference 2016, Chennai, India. (12-14 May, 2016)

Thesis/Dissertations

- Master Thesis (M.Tech): Aravind Babu, Simulation and experimental validation of residual stresses in multi phase steels, Indian Institute of Technology Madras.
- Master Thesis (M.Tech): Durgesh Kumar, Thermodynamics and kinetics calculation for multicomponent alloy design and development towards an ICME approach, Indian Institute of Technology Madras.
- Master Thesis: Shima Ansary (Matr. -Nr. 341745), Microstructure-mechanical properties correlations of intercritically annealed low carbon quenching and partitioning (Q&P) steel. Student was supervised by M. Sc. H. Farivar, Dr.-Ing. U. Prah, RWTH Aachen University, Department of Ferrous Metallurgy.
- Two doctoral theses, one by Mr. Hamidreza Farivar at RWTH Aachen and one by Mr. Deepu Mathew John at IIT Madras are in progress.

Websites

- <http://www.iehk.rwth-aachen.de/index.php?id=681&L=2>
- <https://mme.iitm.ac.in/icme/doku.php?id=public:dpforge>



Following to the development of TCS-PREMAP, the work-flow for macro-work plan for predicting the homogenized mechanical and thermal properties for Simufact simulations were finalized and implemented on TCS-PREMAP. The PREMAP platform is first of its kind and is close to release from TCS.

This project has supported formation of the Laboratory for Integrated Computational Materials Engineering at the Department of Metallurgical and Materials Engineering, IIT Madras. This is the first lab on ICME in any academic institute in India.

Meetings/Conferences/Networking Events

Project related meetings held (Main Meetings)

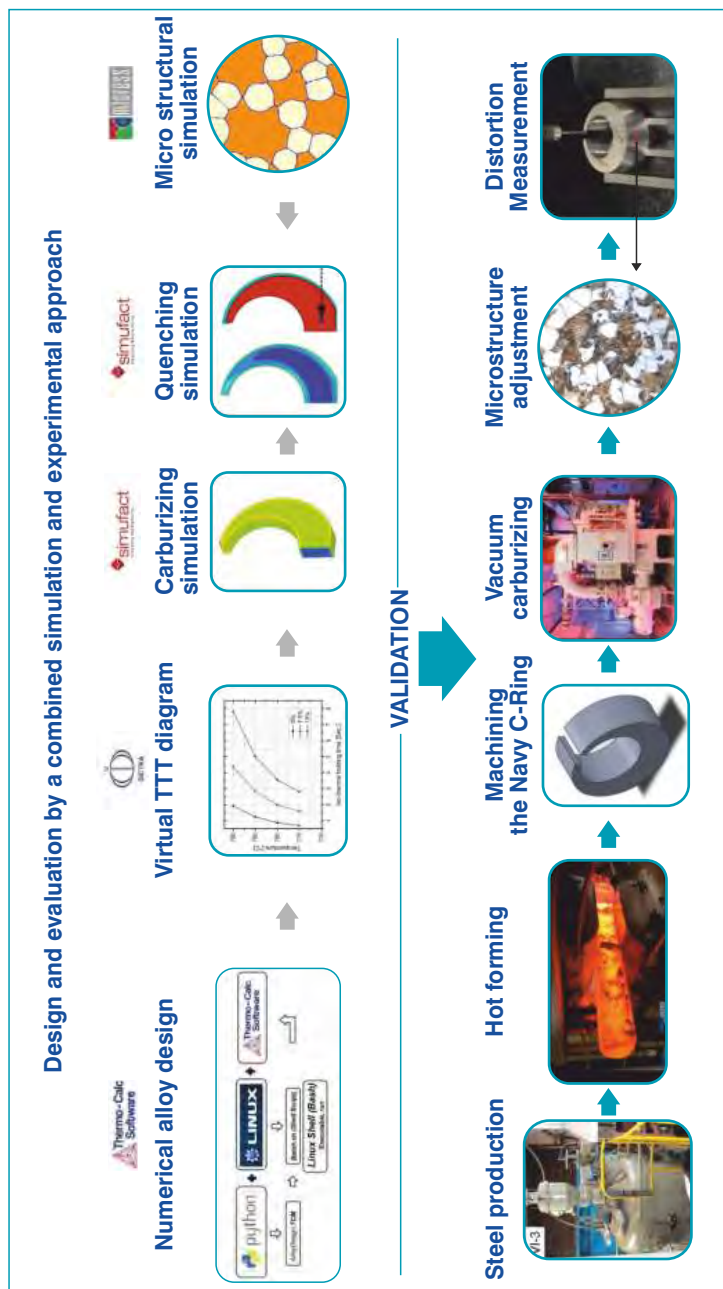
- All partner meet at IIT Madras, India: The meeting was focused on updating the work progress between the partners and finalizing some of the work packages, as some of them needed modifications in the evolving aspects of the project.



- All partner meet at IEHK, Germany, 30th September 2016: The meeting was held to update the work progress from each of the partners and to decide on some of the additions needed to the work packages. A follow-up training for Simufact software was held in conjunction with the meeting



Overall Summary



Gandham Phanikumar
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Tata Consultancy Services
Pune



Ulrich Prael
RWTH Aachen University
Germany



Ralph Bernhard
Simufact Engineering GmbH
Germany



INDEUS

Integration of non-destructive evaluation based ultrasonic simulation

Objectives

A means to optimize structural design and specifically the structural health monitoring (SHM) systems associated to those is achieved by simulation. Many of the simulation tools and algorithms for SHM have been developed at disparate locations and for specific applications. The wide field of SHM encompassing subjects such as materials, structures, fatigue and fracture, physical principles of non-destructive testing (NDT), and possibly much more requires a thorough configuration of networked simulation tools and algorithms leading to something being considered as an open platform for SHM systems simulation and configuration. The main objective of INDEUS is therefore to:

- Establish a simulation platform in non-destructive evaluation (NDE) with an emphasis on SHM
- Facilitate the understanding of physical parameters travelling through arbitrary structures
- Identify an optimum transducer configuration for structures to become self-monitoring in the sense of SHM

Progress made/achieved

- A simulation platform is developed by integrating various different types of simulation data across various existing tools and analyzing the data through an SHM simulation software developed in this project.
- Ultrasonic wave based SHM system design for monitoring defects such a fatigue crack in large and complex structural components was simulated. The simulation results were validated with prototypic testing in India and Germany.
- Ultrasonic Non-Destructive Evaluation (NDE) process was simulated considering various types of components using the simulation platform and process developed.
- A probabilistic approach to SHM system design and evaluation was incorporated in the simulation platform
- SHM sensor system consisting of a network of piezoelectric transmitters and receivers integrated on the structure was optimized with the help of probabilistic damage information from the simulation and the simulated ultrasonic wave data as the guiding information to aid in SHM hardware implementation.
- The overall outcome from the project is the simulation platform and the demonstrated processes that will help to create SHM based concept of designing structures and develop necessary processes for realizing such concept in an actual hardware and further to meet the emerging application needs in the aerospace and infrastructure industries.

- The work package wise outcomes have been documented in a consolidated detailed report.
- Software tool developed by IISc is planned to be brought out for licensing and distribution among the partners and further enable industry transition through various types of simulation benchmarking efforts which are underway.

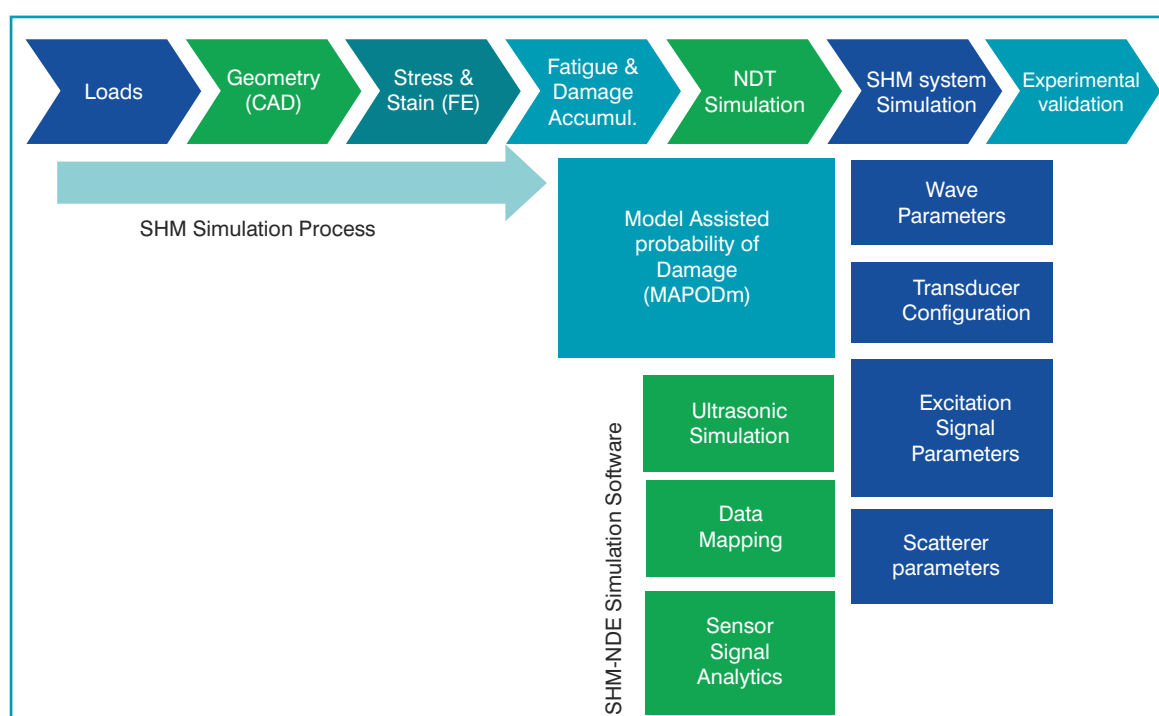
Publications

Integration of Non-Destructive Evaluation based Ultrasonic Simulation (INDEUS) – A Means for Simulation in SHM, Christian Boller, D. Roy Mahapatra, Ramanan Sridaran Venkat, Nitin Balajee Ravi, Nibir Chakraborty, Rakesh Shivamurthy, Keerthy M. Simon, SHM Journal (accepted for publication) 2017.

A Study of Effectiveness of an SHM Sensor System for Fatigue Damage Inspection, Nitin B Ravi, Nibir Chakraborty, Mirko Steckel, Punith Betagiri, Padmanaban Raghuraman, Rakesh Shivamurthy, Ramanan S Venkat, D Roy Mahapatra, Christian Boller, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.

Simulation Based Optimization of Sensor Network for SHM of Complex Structures, Nitin B Ravi, Nibir Chakraborty, D Roy Mahapatra, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.

Ultrasonic Guided Wave Simulation Performance Evaluation for QNDE-SHM Processes Nitin B Ravi, Ramanan S Venkat, Nibir Chakraborty, D Roy Mahapatra, Christian Boller, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.



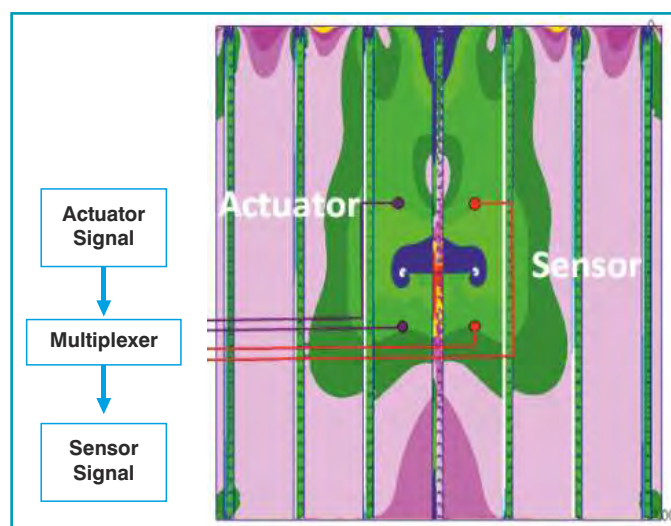
Structural health monitoring system simulation platform describing the simulation process flow and the software platform developed

Integration of Non-Destructive Evaluation based Ultrasonic Simulation (INDEUS) A Means for Simulation in SHM, Christian Boller, D Roy Mahapatra, Ramanan S Venkat, Nitin B Ravi, Nibir Chakraborty, Peter Starke, Mirko Steckel, Dwarakanath Krishnamurthy, 8th European Workshop on Structural Health Monitoring (EWSHM 2016), 5-8 July 2016, Bilbao, Spain.

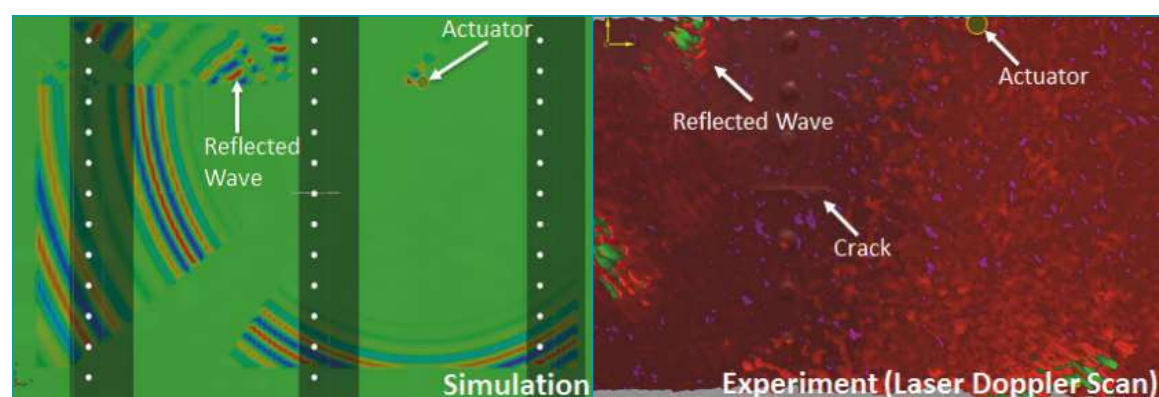
Ultrasonic Guided Wave Sensor Network Optimization for Monitoring Rivet Line, Nitin B. Ravi, Nibir Chakraborty, D. Roy Mahapatra, 10th International Workshop on Structural Health Monitoring 2015 (IWSHM 2015), 1-3 September 2015, Stanford, USA

Optimized Actuator/Sensor Combinations for Structural Health Monitoring: Simulation and Experimental Validation, 1-3 September 2015, Stanford, USA, C. Boller, N. B. Ravi, N. Chakraborty, G. S. Kamalakar, K. Ukirde and D. Roy Mahapatra, 10th International Workshop on Structural Health Monitoring 2015 (IWSHM 2015), 1-3 September 2015, Stanford, USA.

Modeling ultrasonic NDE and guided-wave-based structural health monitoring, Nitin B Ravi, Vivek T Rathod, Nibir Chakraborty, D Roy Mahapatra, Ramanan Sridaran, Christian Boller, SPIE Smart Structures and Materials+ Nondestructive Evaluation and Health Monitoring, 2015, April 1, Proc. SPIE, 9437, Structural Health Monitoring and Inspection of Advanced Materials, Aerospace, and Civil Infrastructure 2015, 94371V.



Principle of a SHM system with ultrasonic sensors and actuators presented on the structural component along with fatigue damage probability simulation results that helps in identification of optimal network of sensors and actuators



Propagation of guided waves in a stiffened panel of an aircraft fuselage and wave scattering from crack.

Technology Transition: The project established an SHM simulation process flow which was verified with the help of various commercial tools, simulation data and experimental tests developed by respective partners. To bridge the existing gaps in the simulation process, which are in the areas of data integration process, ultrasonic sensor network design and signal simulations, an Ultrasonic NDE-SHM Simulation Software was developed by IISc. The software tool developed is proposed to be used further in extensive simulation and computational benchmarking efforts with industries including Airbus.



Prototype Testing under way at IMA Dresden Facility



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Indian Institute of Science
Bangalore



Dwarakanath Krishnamurthy
Tech Mahindra
Bangalore



Christian Boller
Universität des
Saarlandes



Rainer Franke
IMA
Dresden



LowCostEPS

Low-cost emergency power system based on printed smart supercaps

Objectives

Roll-to-roll printable supercap stack for low and medium power EPS systems

- Roll-to-roll printable porous high conductive carbon based ink for electrodes
- Printable electrolyte ink with conventional ionic material
- Printable current collector material
- Supercapacitor setup with 1 Wh/kg
- subsequent inline processing technology for layered capacitor stack (roll-to-roll printing, post-press)
- composition and connecting technology

Low-cost paper-based web for R2R-supercap

- Paper-based high density material as substrate for on-top supercap
- Paper-based low density material as separator between electrodes
- Paper-based high density material with integrated current collector

Low-cost converter circuitry for EPS system

- Supercap charging and discharging concept
- Concept form layer interconnection in printed stack
- Scalable converter technology for different supercap performances
- Connection technology circuitry/supercap

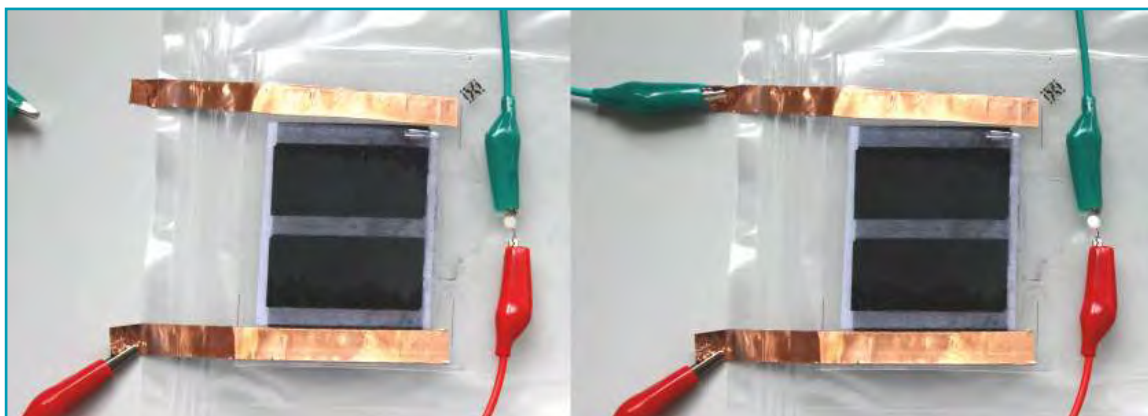
Environmental friendly and high ionic conductive solid state or polymer electrolyte

- Water-based ionic conductive material
- Organic or alcohol-based ionic conductive material

EPS demonstrator system for Indian environment

- Supercap and circuitry for integration in 2.5 till 10 kVA system





Progress made/achieved

Major Activities

- Various active materials were prepared and tested for supercapacitor

Specific Objectives

- Polyaniline based supercapacitor
- Poly (3,4-ethylenedioxythiophene) based supercapacitor
- Activated carbon based supercapacitor
- Polymer-carbon hybrid materials for supercapacitor
- Printable gel electrolyte

Key outcomes

- Active materials with energy density of 6 to 12 Wh/kg were obtained.
- PVA-H₂SO₄ and PVA-H₃PO₄ based gel electrolytes were successfully tested in open air configuration for 1 month.



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Indian Institute of Technology
Bombay



Anil Kumar Muniswamy
SLN Technologies
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Arved Hubler
TU Chemnitz
Chemnitz



Ulf Ender
GRUNPERGA Papier GmbH
Grünhainichen



METNETWORK

Nanostructured hybrid transparent network electrodes for large area visible transparent solar cells

Objectives

The main objectives of the project are

- To examine the feasibility of printing methods to develop large area TCE metal network
- To synthesize the metal network TCE on flexible substrates such as PET or PEN or paper
- To test the feasibility of alternative metalation method based on solution processing techniques and/or incorporating graphene
- To integrate these TCEs in large-area solar cells suitable for window applications

The uniqueness of this approach is its simplicity and suitability for any kind of metals and their precursors. Since we can control the metal fill factor and the structural width of the metal network by tuning the width of cracks in the polymer film, the conductivity and transmittance of such TCEs can be tuned. In collaboration with the industry partners, the chemistry and the process will be adapted to large area substrates, flexible substrates and printing techniques. We expect to fabricate large area TCE by a general concept based on polymer cracked template, which is very universal and simple. Therefore, it is of general use wherever transparent thermal/electrical conduction is desired. The proposed work will provide viable solutions to the pertinent issues related to fabrication of large-area ITO-free TCEs. The application of these electrodes is extendable to other applications such as thermal heaters, sensors, and electrochromic or thermochromic devices. This innovative concept of nanostructured hybrid TCE is a big step towards smart window applications suitable for building integrated photovoltaics.

Progress made/achieved

All the objectives/milestones are under good progress. The first deliverable is due only on the month of 18. The first joint project workshop and kick-off meeting of IGSTC 2+2 project was held at the University of Bayreuth, Bayreuth, Germany from 26th to 28th October 2016. Thus the project got started only in October 2016, after a short delay in getting the financial sanction for the Indian partners. At the Kick-off meeting all the partners agreed on a work programme for the next one year and for possible mutual visits for students. Additionally all the partners have agreed to a joint cooperation agreement and signed the same in April 2017. UBT has ordered a sputtering machine to be capable of sputtering AZO in order to obtain novel hybrid electrodes. The machine will be installed in the month of May 2017 and the planned student exchange from Bangalore to UBT is scheduled for June to August 2017. The details of progress and planned work from each partner are described below.

Partner 1 (CeNS)

(concerning WP1) CeNS has attempted to upscale the process of crackle lithography for the fabrication of low cost TCEs by adapting different coating processes. Spray-roll coating proved to be successful in fabricating up to 10 inch wide crackle film and the spray process has been optimized to achieve 12-15 μm wide uniform and stable crack patterns. A4 size films have been fabricated by rod coating and A3 size uniform films have been achieved through spin coating. However, dip coating proved to be little successful for larger area. Metal deposition on these films was carried out and the as-prepared transparent conducting electrodes are shown to find applications in smart windows and large panel displays.

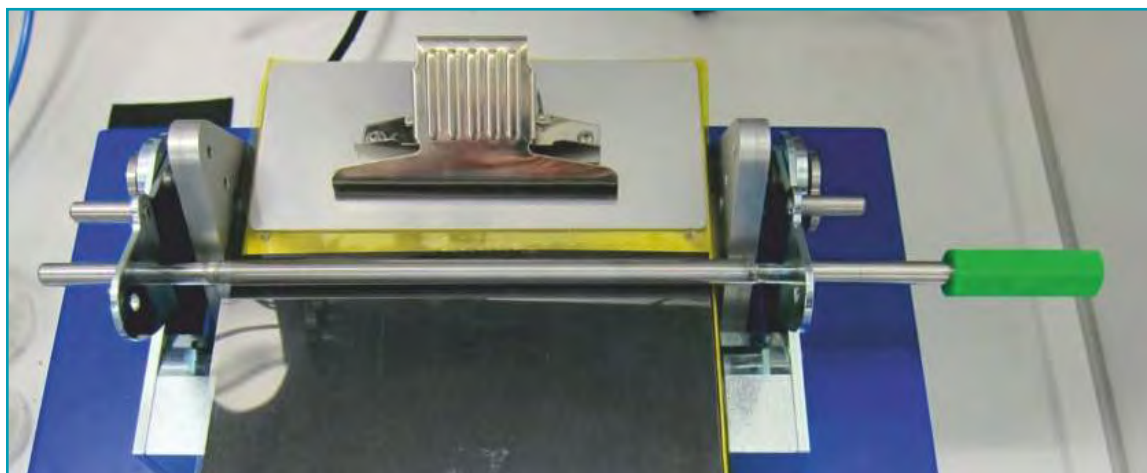


Fig. 1: Roll coater used at UBT to obtain polymer dispersion films on 10 cm x 10 cm PETfilms.

Partner 2 (Tata Steel: TSL)

(concerning WP2) TSL is attempting to grow graphene on low melting point substrate by exploring PECVD process. Commercial PECVD setup has been modified by adding a home built solid precursor vaporizer at PECVD gas inlet pipe. Further studies are in process which involves feeding of natural precursor vapour into the PECVD through gas inlet valve, to convert to graphene which gets adhered to the substrate maintained at room temperature. This study will help in understanding the growth parameters and property of grown film when chemically reactive plasma of precursor molecules is exposed to substrates at different temperatures.

Partner 3 (UBT)

(concerning WP1) UBT has screened different polymer dispersions, which can be used as a template to obtain a metal mesh network. Among these, several polymer dispersions showed uniform micrometer scale cracking during thin film formation, especially dispersions having a minimum film formation temperature $> 50^{\circ}\text{C}$. One candidate of polymer dispersion was chosen for testing on PET substrates. First metallization tests were done with thermal evaporation (sublimation). The light transmission for the 60 nm thick Ag network on PET foil (23 μm) was 95% in the wavelength range between 300 nm and 1000 nm. The sheet resistance of the foil was 32 ohm/square. Metallization based on wet chemistry have not done up to now. The candidate was further sent to the German industry partner (PL) for printing this polymer dispersion on a Roll-to-Roll pilot printer.

Partner 4 (PL)

(concerning WP1 and WP4) PL ordered polymer dispersions with different minimum film formation temperature and sent them to UBT for screening their suitability as template material for crackle lithography. After UBT found a suitable polymer dispersion, PL optimized the dispersion for a R2R pilot printer. This optimization is still ongoing, due to special issues of the water based dispersion on PET foil. At present, several additives for influencing the surface tension and rheology are under investigation.

Specific Objectives

Larger area low cost TCEs have been prepared successfully by different coating methods. The as prepared TCEs can be made use of in applications such as smart windows and large panel displays as reported in S. Kiruthika and G.U.Kulkarni, Solar Energy Materials and Solar Cells, Volume 163, April 2017, Pages 231–236.



Fig. 2: Optical microscope image of the Ag-mesh network prepared on a 23 µm thick PET foil at UBT.



Fig. 3: Photograph of a PET foil with the Ag-mesh network prepared at UBT. The opaque metal part on the foil was used to measure the sheet resistance. The light transmission through the PET foil was 95% in the wavelength range between 300 nm and 1000 nm. The sheet resistance of the foil was 32 ohm/square.

Publications

Journals/Books/Book Chapters /Conference Papers /Presentations/Other Publications

- Energy efficient hydrogel based smart windows with low cost transparent conducting electrodes, S. Kiruthika and G.U. Kulkarni, Solar Energy Materials and Solar Cells, Volume 163, April 2017, Pages 231–236
- Fabrication of solar and electrically adjustable large area smart windows for indoor light and heat modulation, A. K Singh, K. Shanmugam, I. Mondal and G. U. Kulkarni, J. Mater. Chem. C, 2017. 10.1039/C7TC01489A

Meetings/Conferences/Networking Events

Discussion during kick-off meeting and group photo of all participants of the kick-off meeting in October 2016 at Bayreuth



Fig. 1: Discussion during kick-off meeting



Fig. 2: Group photo of all participants of the kick-off meeting in October 2016 at Bayreuth



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Winfried Hoffmüller
Papierfabrik Louisenthal GmbH (PL)
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MIDARDI

Microfluidic based detection of microbial communities and antibiotic responses in the management of diabetic foot ulcers

Objectives

Europe and India face an epidemic of obesity and Type 2 diabetes (T2D). Development of T2D strongly correlate and very often predisposes to increased risk of many disabling chronic diseases including Lower Extremity Amputations (LEA) such as foot infections. Bacterial communities in such foot infections show diverse morphological and physiological characteristics and their bioburden in diabetic foot ulcers (DFU) show a distinct pattern of antibiotic resistance which significantly delays wound healing. Though infected ulcers require proper antibiotic therapy, rapid and accurate detection of polymicrobial communities in wound environment is critical in proper wound management. In this polymicrobial setting, the project aims at

- Developing a microfluidics-based lab-on-a-chip for rapid and accurate detection of different types of bacteria, their virulence/fitness factors and antibiotic resistant genes that may contribute to dominance of certain types in DFU settings.

In particular, targeted objectives include:

- Assay development for species identification and antibiotic resistance testing based on gene and mutation detection
- Fully-integrated, disposable Lab-on-a-Chip System to perform DNA sequence detection assays
- Readout unit dedicated to local environment to demonstrate species and drug resistance testing of pathogenic bacteria
- Proof-of-concept of mutation detection for translation

Progress made/achieved

- Different use case scenarios were evaluated, and technical requirements and specifications were derived both from a user and a market perspective. From the microbiological analysis perspective, 142 foot ulcer wound samples were collected from 130 patients (101 diabetic and 41 non diabetic individuals). Based on the wound and severity, each sample was assigned a Wagner grade. A total of 168 wound strains have been isolated and the dominant microbes were identified. Culture independent analysis was carried out by sequencing the 16S rDNA gene using the ION PGM platform. A total of 237 genera were classified and of these, the dominant phyla across all grades were Proteobacteria and Firmicutes, consistent with the culture results. Wound microbiomes show high degree of interindividual variability. Beta diversity analyses across all wound samples with grouping criteria of Wagner grade and disease status did not show any distinct clusters. We selected the dominant bacterial species from our culture-based results as representatives for resistance studies and targeting resistance markers for rapid identification.

- Relevant genes for species identification and resistance detection were defined. An identification of Methicillin Resistant Staphylococcus aureus (MRSA) was established as most relevant. In order to identify bacterial species and further differentiate between Staphylococcus species a DNA microarray was developed. The microarray consists of specific probes for species identification as well as probes for relevant antibiotic resistance detection. To distinguish S. aureus from other Staphylococcus species, such as S. haemolyticus and S. epidermidis, the identification of single- nucleotide-polymorphisms (SNPs) was necessary, and successfully achieved, resulting in an array containing 10 non-SNP and 6 SNP probes.
- On the instrumentation and hardware aspect of the Lab-on-a-Chip, user and technical requirements for the proposed product have been identified. A successful proof-of-concept for a technological merge between BiFlow's cartridge technology and Achira's sensing technology has been demonstrated. A Thyroid Stimulating Hormone (TSH) assay from Achira's Acix platform was run seamlessly on a BiFlow flex.flow cartridge. Control electronics has been developed being able to both control all the integrated heating and pumping steps required for both the species and drug resistance assay. First cartridge demonstrators have been prepared and technically characterized to be able to perform single assay steps in an integrated format during the next months.
- A two-wavelength band detection system with a high dynamic range, low noise has been conceptualized. A monochromatic working prototype has already been setup.

Krona representation of diversity of bacterial in two representative sample

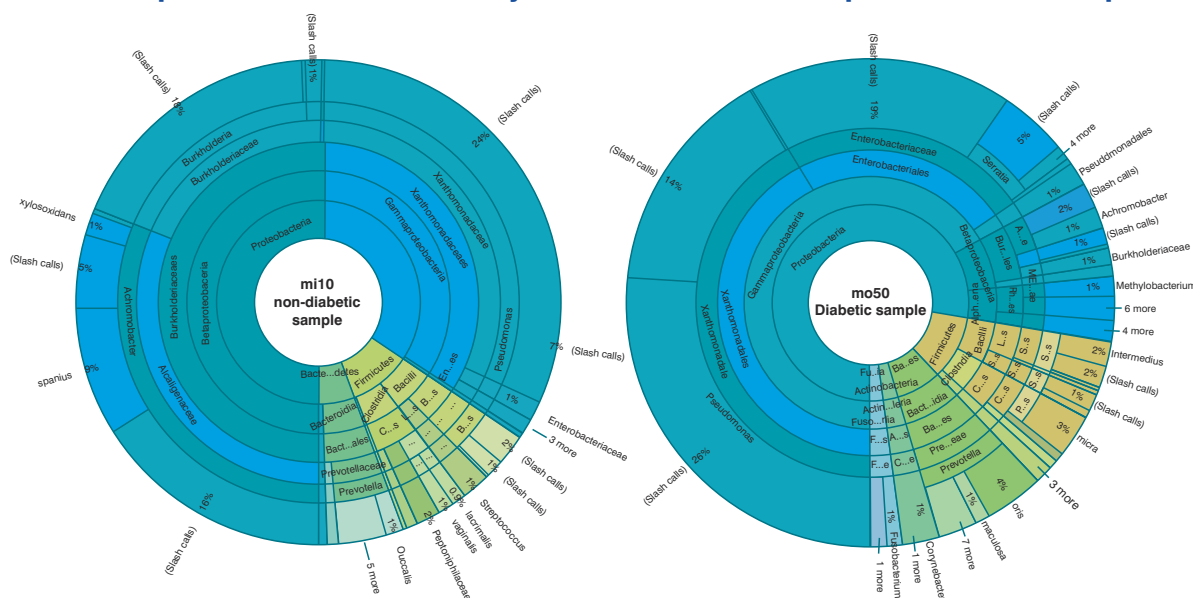


Fig. : Krona representation of diversity of bacterial species in two representative foot ulcer samples (Manipal University)

Publications

Journals/Books/Book Chapters /Conference Papers /Presentations/Other Publications

- Apoorva J, Ramya V, Varghese VK, Chakrabarty S, Paul B, Nestler J, Harald P, Morschhauser A, Bier F, Dendukuri D Murali TS and Satyamoorthy K. (2016). Modelling the wound microbiome: Microbiological insights based on next generation sequencing. 2016 NextGen Genomics, Biology, Bioinformatics and Technologies Conference, Cochin, India

- Kavitha S, Spoorthi J, Deepika VB, Raviraj A, Ramachandra L, Satyamoorthy K, Murali TS. 2017. Virulence determinants in clinical *Staphylococcus aureus* from monomicrobial and polymicrobial infections of diabetic foot ulcers. *Journal of Medical Microbiology* (in press). DOI:10.1099/jmm.0.000370

Non-Scientific communications

The project was referenced

- In a paragraph in the Fraunhofer ENAS' Annual Report 2016.
- As case study of IGSTC-funded projects in the report "Innovation in India 2016" by Bertelsmann Stiftung (http://www.bertelsmann-stiftung.de/fileadmin/files/user_upload/Innovation_in_India_Final_Report_2016.pdf)

Thesis/Dissertations

- Ms. Kavitha S – Ph.D. Thesis entitled "Molecular characterization of bacterial and fungal communities in the diabetic foot ulcer"
- Mr. Ankit Singh Tanwar – M.Sc. Thesis entitled "Genome comparison of four strains of *Staphylococcus aureus* isolated from diabetic foot ulcer"

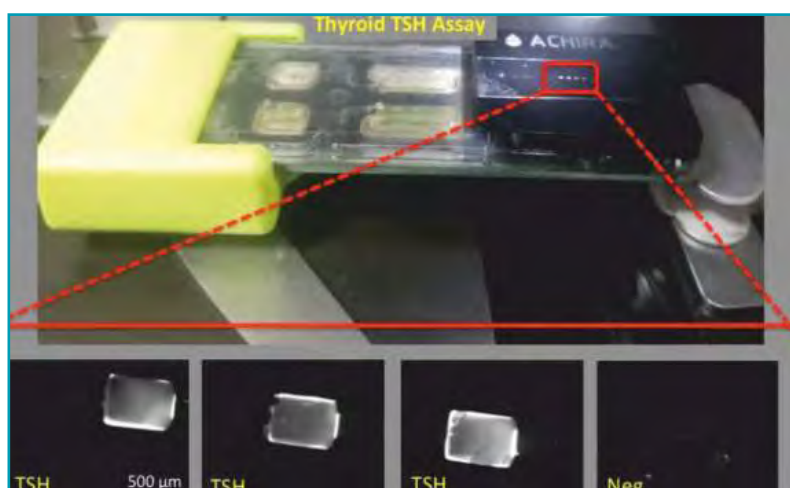


Fig. : Achira's gel-based sensor mounted on a self-pumping microscope slide of BiFlow, automatically running a Thyroid TSH Assay (Achira + BiFlow).

Meetings/Conferences/Networking Events

Project Meeting in India (Bangalore & Manipal), January/February 2016

- The meeting was held at both Indian partner's places, Bangalore for Achira Labs, and Manipal for Manipal University.

Both institutions' facilities were visited. In addition to technical discussions

- The project was presented to the Pro-Chancellor of Manipal University.
- A scientific lecture was given by Prof. Frank F. Bier (Fraunhofer IZI-BB) and Dr. Joerg Nestler (BiFlow Systems GmbH) in front of big Audience of students of School of Life Sciences of Manipal University.



Audience at Prof Bier's lecture at Manipal University

Part of the Consortium visiting Manipal University

Project Meeting in Germany (Potsdam & Chemnitz), June 2016

Besides intensive technical discussions the first project meeting in Germany aimed at visiting the facilities of all project partners. Thus, the meeting started in Potsdam / Berlin at Fraunhofer IZI-BB and was followed by a meeting in Chemnitz at Fraunhofer ENAS and BiFlow Systems GmbH.



Consortium in front of Fraunhofer IZI-BB building in Potsdam-Golm



K. Satyamoorthy
Manipal university
Manipal



Dhananjaya Dendukuri
Achira Labs
Bangalore



Thomas Otto
Fraunhofer ENAS
Chemnitz



Frank F. Bier
Fraunhofer IZI
Potsdam



Joerg Nestler
BiFlow Systems
Chemnitz



MULTI-WAP

Multiplexed, label-free fiber optic biosensor array system for waterborne pathogen detection

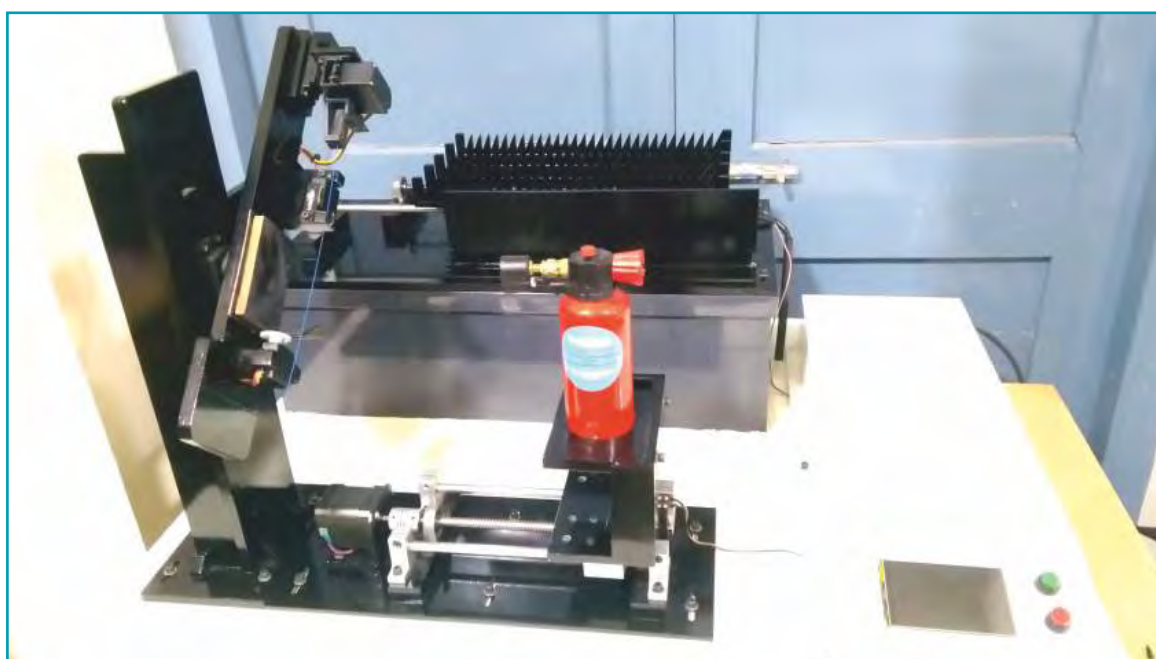
Objectives

- Development of a low-cost label-free array biosensor platform for simultaneous detection of multiple pathogens, consisting of reproducible and sensitive U-bent fiber optic array of probes coated with antibodies specific to pathogens, working on the principle of changes in the intensity of light at 280 nm passing through the fiber probe as pathogens bind specifically a particular probe by virtue of evanescent wave absorbance phenomenon. This sensing principle has been established by the partner from IIT Madras in case of single pathogen detection. The probes have ability to give rise to a distinguishable signal upon binding of 5 to 10 cells.
- Fabrication of novel compact and disposable U-bent fiber optic probe array cartridge consisting of 8 or more identical U-bent probes (200 m fiber core, 1.5 mm bend diameter) having high sensitivity, which are fabricated by means of a precise mechanism of rotating arms and a CO₂ laser for holding fiber ends and heating the fiber core for bending into U-shape.
- A novel silica-based fiber surfaces coating and modification chemistry working from the gas-phase that allows a cost-effective, eco-friendly and up-scalable primary functionalization with electrophilic reactive groups able to bind the required antibodies.
- Production of novel detection systems, based on unique combinations of high-quality antibodies for different biomarkers for waterborne pathogen and for non-pathogenic E.coli as model analytes. Research by LIONEX has led to the development of a proprietary novel antibody which can specifically bind the model analytes targeted in the project. LIONEX is well equipped for all molecular biological and antibody/protein production work under category 2 laboratories.
- Development of the optoelectronic instrumentation for biosensor device/equipment consisting of a UV light source with suitable optics (including filters and lenses) and a UV-sensitive CCD with suitable coupling optics integrated into a single unit with a removable/reloadable U-bent probe array in the form of a cartridge. A lab-prototype device/equipment will be realized and evaluated. Special attention will be paid to achieve the required signal to noise ratio even under non-laboratory condition.

Progress made/achieved

- Optimum geometry of U-bent fiber probes is identified, which helps in design of highly sensitive fiber optic sensor devices
- Surprisingly, preliminary data (not shown in the report) shows that U-bent fiber probes can detect protein binding at 280 nm down to concentrations of 10 ng/ml of immunoglobulin (IgG). Further studies are in progress.

- At IOT, TU Braunschweig, activities in the first 4 months were largely focused on putting into operation new equipment (FTIR spectrometer, electrokinetic analyzer), building plasma-chemical reactors, and evaluating analytical methods to be used for assessing silanization (film thickness, functional group density, stability) of planar model substrates as well as U-bent silica fibers.
- Fiber bending machine is designed. Its development is in progress.
- At LIONEX, initial batches of LAM and the related lipoglycans from *M. avium avium*, *M. avium paratuberculosis* were purified and successfully passed the QC. These batches will be used to raise antibodies and as controls materials.
- A first batch of anti-non-pathogenic *E.coli* as model analyte was produced. The purified antibodies were subjected to extensive quality control (QC) involving ELISA, SDS-Gel electrophoresis on an automatic GLP-certified platform which separates the proteins, stains, de-stains and quantifies all protein bands and thus clearly shows the purity of the antibody preparations. These antibodies will be used as model analyte for Multi-WAP platform.
- The biomarkers production of for waterborne pathogens in progress.



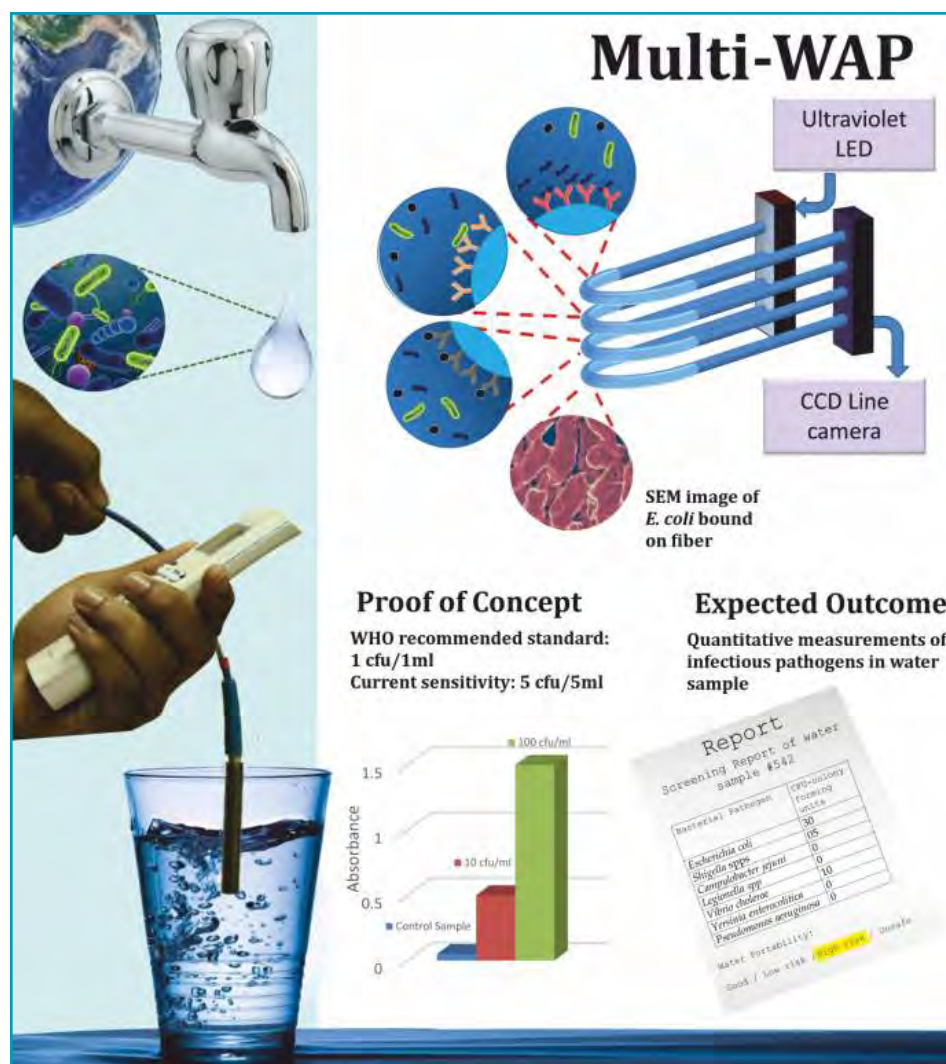
Fiber Bending Machine V1 with gas flame

Dissemination activities

Promotional material (flyer, poster, short presentation template) establishment under intensive progress at ubio and will be distributed soon.

A newsletter template creation in progress and will be sent out to a user forum containing key players and experts from industry and academia.

On the occasion of the project kickoff, IIT Madras presented the project to number of students and participants. They also decided also to send out a press release.



Successful implementation of the project is expected to yield the following results

- A portable, optical absorbance-based, ultra-sensitive water pathogens detection device, which can be adapted to other pathogen detection applications.
- A removal 'plug & play' cartridge to house the biochip and to provide a secure environment for the analysis.
- Optimized analysis protocols for successful pathogen detection.

With the novel multimarker assay, Multi-WAP will also be the first system capable of detecting of up to 7 or more waterborne pathogens at the same time. Furthermore, the pathogen detection time is also greatly reduced (mins) compared to the state of the art (days).



Fiber Array Sensor with Laser and CCD detector



V. V. Raghavendra Sai
IIT Madras
Chennai



V. I. Bishor
Ubio Biotechnology Systems Pvt Ltd
Cochin



Claus-Peter
Technische Universität Braunschweig
Braunschweig



Mahavir Singh
Lionex GmbH
Braunschweig



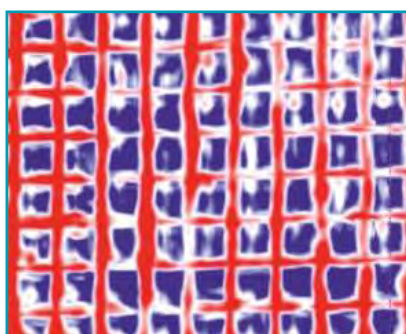
NDT DATA FUSION

Visualization of automated multi-sensor NDT assessment of concrete structures

Objectives

The main goals of the project are:

- To develop and Implement automated scanner system for data collection using multi-sensor (Ground Penetrating Radar (GPR), Ultrasonic Pulse Echo (UPE), and Impact Echo (IE)).
- Development of software tool for visualization of data using data fusion technique by combining radar, ultrasonic pulse echo and impact echo.
- Evaluation of various inclusions, defects, thickness and voids in concrete structures using multi-sensor techniques.



Top Reinforcements obtained with radar

Progress made/achieved

Salient Research Achievements

A systematic approach for fusion of multi-sensory nondestructive testing (NDT) data was developed to improve the detectability of honeycombs by fusing the information from the three different sensors.

A prototype (demonstrator) was developed at BAM (GER) and was delivered to CSIR-SERC (IND). Tests in laboratory and preliminary field tests were carried out with this demonstrator. Data was collected on a number of large scale concrete specimens containing distinct built-in honeycombing defects and varying thickness.

The description of the concept for software integration and outline of the visualization concept has just begun. A description of the technology, which enables the scanner to move in its foreseen grid and schedule, has already been made.

The system is able to acquire data from commercially available sensors. The collected data is display to the operator immediately. Data Processing (filtering, noise removal etc.) has been

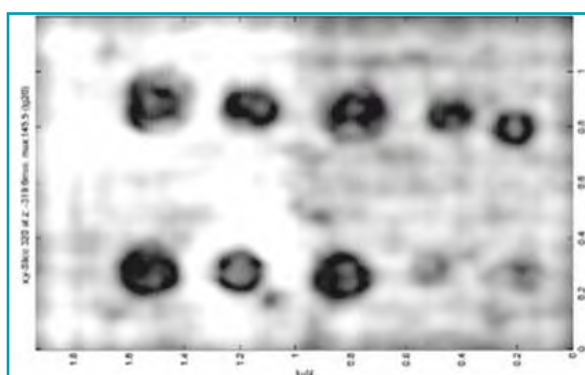
implemented for UPE and GPR data. Figure below shows the data collection using automated scanner with radar and UPE on a large concrete slab containing different sizes of honeycombs with two layers of reinforcement mesh.

Field tests under consideration of typical practical problems were performed in diaphragm walls and parking garages. The evaluation of the performance of the approach will be conducted as soon as the experimental investigations are completely evaluated.

The automated scanner has been erected on the vertical face of a concrete wall in the laboratory using suction feet and trial runs were performed. Measurements are being planned on a large scale I-girder beam of 20 m span as part of the field studies. Investigations for the nondestructive testing of pitting corrosion have been initiated. The schedule for this experiment includes multi sensor reference measurements in the beginning. Afterwards the chloride is induced to the concrete and pitting corrosion is initiated on pre-defined locations.

Afterwards new features indicating pitting corrosion are to be found. Corrosion data in field was already collected and will be evaluated after the laboratory investigations are completed.

Part of the work has been presented in a few scientific meetings (DGZFP – Annual Meeting 2014), conferences, and recently accepted for publication in NDT&E, a prestigious journal in the field of NDT. Another article dealing with more sophisticated fusion algorithms for honeycomb data has just been submitted to NDT&E



Detection of Honeycombs in concrete slab using UPE

Field Tests

Field tests were performed on the diaphragm walls of Metro Rail Limited. The tests were performed on the diaphragm walls measuring thickness up to 1.0 m. Diaphragm walls are constructed using tremie concrete technique. In the process of construction, the thickness of wall at some locations may increase or decrease depending on the caving of sand. Also, due to congestion of reinforcement and the difficulty in the construction technique, defects in the form of voids are bound to be present. It is essential to estimate the thickness non-destructively using advanced non-destructive methods such as ground penetrating radar, impact echo and pulse echo technique.

A deep beam of old stadium was also instigated using the automated scanner and the data was collected using different sensor heads. The data was processed using the post processing software.

In addition, few full scale buildings at CSIR-SERC were also evaluated using the automated scanner. The scanner was very useful in the collection of data with different sensor heads very accurately.

Publications

P. Srinivasan, & S.G.N. Murthy, "State of the art in the automated scanning of NDT in concrete" CSIR-SERC Research Report No. R & D -02 CLP-004-RR-01, December 2013

P. Srinivasan, & S.G.N. Murthy, "Evaluation of voids and reinforcement in thick concrete slabs using radar and ultrasonic pulse echo", CSIR-SERC Research Report No. R&D-02 CLP-0041, May 2014

C.Völker and P.Shokouhi, "Multi sensor data fusion approach for automatic Honeycomb detection in concrete," NDT&E, Vol. no.71, pp .54-60, April 2015.

P. Srinivasan, D. Ramakrishnan, S. Maruthi, "Determination of spacing and radius of rebar in concrete specimen", CSIR-SERC Research Report No. R&D-03, CLP-0041, May 2015

C.Völker and P.Shokouhi, "Clustering Based Multi sensor data fusion for Honeycomb detection in concrete", Journal of NDE, 01/2016; 34(4):34:32 1-10, September 2015.

P. Srinivasan, S.G.N Murthy, D. Ramakrishnan and K. Vasanth, "Evaluation of Thickness and Defects in Diaphragm Walls Using Impact Echo", International Journal of Applied Engineering Research (IJAER), Volume 10, Number 62(2015), Special Issues, pp.428-430.

Srinivasan, S.G.N Murthy, D. Ramakrishnan and K. Vasanth, "Evaluation of Thickness and Defects in Diaphragm Walls Using Impact Echo", International Journal of Applied Engineering Research (IJAER), Volume 10, Number 62(2015), Special Issues, pp.428-430.

Visualization of automated multi-sensor NDT assessment of concrete structures (NDT Data Fusion) - Poster presented at the IGSTC Annual Event, 2016.

Expertise in the area of advanced non-destructive testing for concrete structures has been created namely ground penetrating radar, ultrasonic pulse echo and impact echo techniques since 2007 at CSIR-SERC (first of its kind in India). In view of the IGSTC sponsored project on NDT DATA FUSION, the automated scanner has been procured from BAM, Berlin and successfully installed at CSIR-SERC. This is the first of its kind in India. In addition the collaboration with BAM, Berlin, Lucid software India Limited, Chennai and Specht, Kalleja + Partner GmbH +, Germany have helped in the processing of data and also for establishing the advanced NDT facility using automated scanner



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THOMAS KIND
Bundesanstalt für Materialforschung und
-prüfung (BAM)
Berlin



ANDRE MOLKENTHEIN
Specht, Kalleja + Partner GmbH
Berlin



NPORE

Development, characterisation and validation of nano-porous particles for the adsorption of hydrophobic uremic toxins in renal failure patients

Objectives

Development, characterisation and validation of adsorbant particles for the removal of uremic toxins from plasma of chronic renal failure patients.

Objective/WP 1

- 1.1: Preparation using established methods of a sufficient quantity of PEI particles of defined size and porosity
- 1.2: Establishment of processes for hydrophilic functionalization of PEI particle surface
- 1.3: Preparation of PEI microparticles with functionalized inner core without influencing the hydrophilic, hemocompatible outer surface coating".

Objective/WP 2

- 2.1: Assessment of the adsorption of toxins to newly designed modified PEI microparticles by means of preparative & RP-HPLC
- 2.2: Quantification of UTs adsorption by newly designed modified PEI microparticles by using different chromatographic techniques
- 2.3: Quantification of UTs adsorption by newly engineered PEI microparticles in presence of albumin by using different chromatographic techniques

Objective/WP 3

- 3.1: First biocompatibility studies of PEI-particles after sterilization are done
- 3.2: Final characterization (biocompatibility) of PEI-particles after sterilization

Objective/WP 4

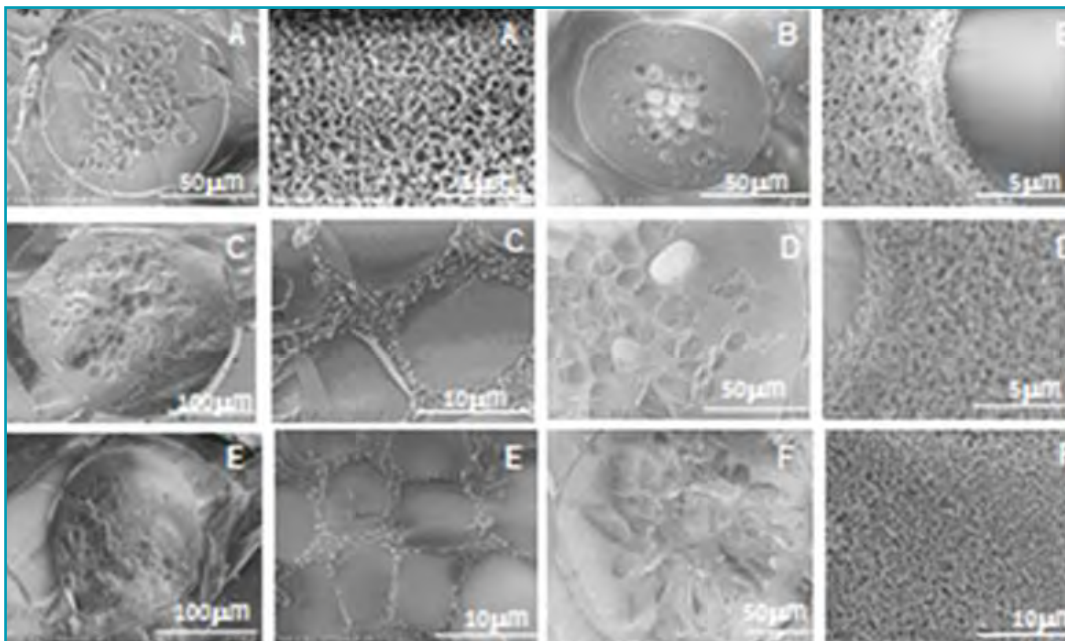
- 4.1: Determination of inflammatory markers of peripheral blood monocytes before/after interaction with PEI-particles
- 4.2: Determination of inflammatory markers of cultured vascular cells before/after interaction with PEI-particles
- 4.3: Apoptotic effect of PEI particles on vascular cells

Objective/WP 5

- 5.1: Determination of biocompatibility of PEI particles using animal models
- 5.2: Development of animal models of chronic kidney disease and quantification of hydrophobic uremic toxins
- 5.3: Determination of hydrophobic uremic toxin adsorption by PEI particles in animal models of CKD

Progress made/achieved

- Major Activities: Developed validated nano-porous particles for the adsorption of hydrophobic uremic toxins in renal failure patients and characterized their biocompatibility using human cellular models.
- Specific Objectives: As per the specific objectives mentioned above, made progress in all four work packages (WP1 to WP4) excepting work package 5, which was proposed with animal models.
- Key outcomes or any other achievements: Modified/Functionalised nano-porous particles showed high affinity for hydrophobic uremic toxin and low affinity for serum albumin. Also, the particles showed hemo-compatibility and no cytotoxicity on human monocytic and vascular cells. Therefore, the particles developed are good candidates for further testing toward their clinical usage for CKD patients.



Cryo-SEM thumbnails of relevant surface morphology of cryo-opened PEI particle's surface (PEI-ET to PEI) visualized at different structural levels. Lower magnification images precede the higher magnification images for each type of microparticles. Figure legend: A : PEI-ET; B : PEI-DET; C : PEI-PVP-I; D : PEI-PVP-II; E : PEI-PEG; and F : PEI

Publications

Basu, S.; Heuchel, M.; Weigel, T.; Kratz, K.; Lendlein, A., Integrated process for preparing porous, surface functionalized polyetherimide microparticles. *Polymers for Advanced Technologies* 2015, 26 (12) 1447-1455.

Kumar, R. K.; Basu, S.; Lemke, H.-D.; Jankowski, J.; Kratz, K.; Lendlein, A.; Tetali, S. D., Effect of extracts of poly(ether imide) microparticles on cytotoxicity, ROS generation and proinflammatory effects on human monocytic (THP-1) cells. *Clinical Hemorheology and Microcirculation* 2015, 61 (4) 667-80.

Tetali, S. D.; Jankowski, V.; Luetzow, K.; Kratz, K.; Lendlein, A.; Jankowski, J. Adsorption capacity of poly(ether imide) microparticles to uremic toxins; *Clinical Hemorheology and Microcirculation* 2015, 61 (4) 657-65.

Kumar RK, Basu S, Lemke HD, Jankowski J, Kratz K, Lendlein A, Tetali SD. Influence of nanoporous poly (ether imide) particle extracts on human aortic endothelial cells (HAECs). *Clin Hemorheol Microcirc.* 2016 64(4):931-940

Heuchel, M.; Gerber, D.; Kratz, K.; Lendlein, A., Morphological analysis of differently sized highly porous poly(ether imide) microparticles by mercury porosimetry. *Polymers for Advanced Technologies* 2016, published online at 14 NOV 2016, DOI: 10.1002/pat.3973.

Braune, S.; Basu, S.; Kratz, K.; Johansson, J. B.; Reinthaler, M.; Lendlein, A.; Jung, F., Strategy for the hemocompatibility testing of microparticles. *Clinical Hemorheology and Microcirculation* 2016, 64, 345-353.

Marieke Rueth, Horst-Dieter Lemke, Christian Preisinger, Detlef Krieter, Wendy Theelen, Prathiba Gajjala, Eric Devine, Walter Zidek, Joachim Jankowski, Vera Jankowski: Guanidynylations of albumin decreased binding capacity of hydrophobic metabolites; *Acta Physiol (Oxf)*. 2015;215:13-23.

Thesis/Dissertations:

PhD student: Marieke R  th (eXcorlab) (supervisor: JJ, RWTH IMCAR): " Hydrophobe Metabolite der Ur  mie: Proteinaffinit  t, Quantifizierung und methodische Ans  tze zur Untersuchung vaskul  rer Effekte", finished in 02-2016.

In addition to journal papers , seven conference papers have also been published

Meetings/Conferences/Networking Events



One of the formative group meeting discussing the chromatograms of the eluted UTs from PEI-based microparticles and issues dealing with experimental setup.



Annual NPORE Partners's Meet at University of Hyderabad, India

- Project related meetings held: Three NPORE partner's meetings were held during the project period and the 3rd annual meet in Jun 2016 was hosted by IMCAR, Aachen, Germany
- Conference attended: Reddi Kiran Kumar. Ph.D. student of Prof. Sarada D. Tetali, University of Hyderabad, India attended Jahrestagung der Deutsche Gesellschaft für Klinische Mikrozirkulation und Hämorheologie (DGKMH) November 27/28, 2015, Regensburg, Germany.
- Project related personnel exchange: Reddi Kiran Kumar. Ph.D. student of Prof. Sarada D. Tetali, University of Hyderabad, India visited Prof. Joachim Jankowski's laboratory, by IMCAR, Aachen, Germany



Sarada D. Tetali
University of Hyderabad
Hyderabad



J. Jankowski
RWTH Aachen University
Aachen



Karl Kratz
Helmholtz Zentrum Geesthacht
Berlin



H. D. Lemke
eXcorLab GmbH
Obernburg



REMSOLAR

Reduction of earth metals in chalkopyrite-based solar cells

Objectives

- Model process for Copper indium gallium selenide (CIGS) growth with reduced layer thickness and preserved or improved photovoltaic properties.
- Model process for Kesterite growth with reduced layer thickness and preserved or improved photovoltaic properties.
- Report on scientific and economic potential of both approaches and benchmarking.

Progress made/achieved

- For CIGS solar cells with reduced material consumption, MLU showed a largely improved solar cell efficiency on $1\ \mu\text{m}$ CIGSe films.
- For the Earth abundant $\text{Cu}_2\text{ZnSnS}_4$ solar cell, a CZTS thin film of controlled morphology and composition has been obtained comprising studies of (1) the type of metal salt (acetate/chloride) and their relative amount in the solution, (2) initial drying after spin coating and high temperature treatment for crystallization. The electrical, optical and microstructural properties of CZTS thin film were tailored by alloying with silver which led to significant improvements in the microstructure. Photovoltaic cells fabricated from the optimized CZTS films resulted into open circuit voltage of 0.62V which is close to the V_{oc} of 0.7V for the best reported CZTS PV cell by M. A. Green et al.
- First thin films of $\text{Cu}_2\text{Zn}(\text{Sn}, \text{Ge})\text{Se}_4$ have been investigated by in-situ XRD, Germanium incorporation of 2% has been achieved.



IR - 1



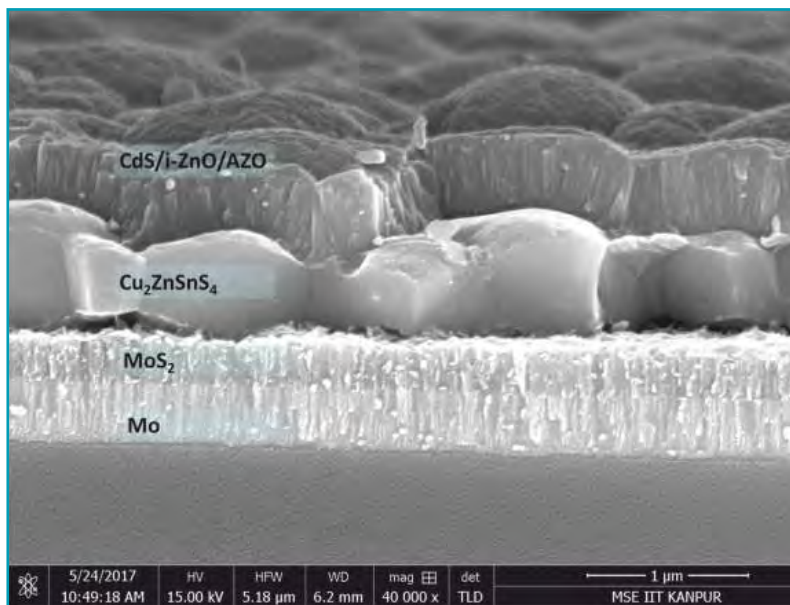
IR - 2

Key outcomes

- Manz consolidated the higher material utilization by changed Se flux is a very important achievement of this project.

Publications

- Stable single-phase Zn-rich $\text{Cu}_2\text{ZnSnSe}_4$ through In doping, S. Hartnauer, S. Körbel, M. A. L. Marques, S. Botti, P. Pistor, and R. Scheer, APL Mater., 2016. 4(7) p. 070701.



Cross-sectional image of CZTS PV device



Sputter System -1



Sarang Ingle
IIT Kanpur
Kanpur



Nagesh Kini
Thermax
Pune



Roland Scheer
Martin-Luther-University
Halle



Ralf Sorgenfrei
Manz CIGS technology GmbH
Schwabisch Hall



RESERVES

Resource and energy reliability by co-digestion of veg-market and slaughterhouse waste

Objectives

The project aims to demonstrate the feasibility of sustainable resource and energy reliability by co-digestion of veg-market and slaughterhouse waste in India and its potential for global realization. In a pilot plant study to be conducted in Chennai, India in the premises of an existing biogas plant currently operated by Ramky Enviro Engineers Ltd and in close vicinity to the Koyambedu Wholesale Market Complex (KWMC) or in the premises of Central Leather Research Institute, the German and Indian partners apply their common developed innovative approach with the following deliverables:

- Demonstration of the feasibility of recovery of bioenergy from fruit and vegetable market waste, slaughterhouse waste and other organic wastes in urban areas in a sustainable way.
- Integration of advanced anaerobic processes in the economic, social and natural environment in context to India.
- Establishment of a sustainable supply chain for the generation of energy through anaerobic treatment of fruit and vegetable market waste, slaughterhouse waste and other organic wastes generated in Chennai City as substrates.
- Avoiding emission of Methane into environment by reducing the disposal of organic wastes in open dumps and also reducing the odour nuisance and other land and water pollution.
- Improvement of the urban hygienic and health conditions through specific slaughterhouse waste treatment with pathogen removal.
- Contribution to local energy supply through generation of bioenergy and also generation of bio-fertilisers/soil conditioner with rich nutrient contents (N, P, K) thus making this energy recovery as sustainable with generation of additional income.

Progress made/achieved

CLRI and ISAH estimated a total amount of approximately 150-200 tons of Vegetable Market Waste (Vegetables (60-65%), Fruits (35-37%) and Flowers (2-3%) per day based on data obtained from the field.

Also, three major slaughterhouses were identified in Chennai, which produce a total maximum amount of about 9 -10 tons of Slaughterhouse Waste (SHW) in a day. The analysis of collected SHW showed that it comprises 12% blood, 3% lungs, 9% small intestines, 7% large intestines and 69% rumen content. Additionally, vegetable market and slaughterhouse wastes were analysed comprehensively regarding their physical properties, chemical characteristics and contents of fibres, lipids, carbohydrates and fats.

The VMW and SHW samples for the biogas potential test were collected according to the guideline VDI 4630. The biogas potential of substrates was measured in batch reactors maintained in mesophilic conditions. The specific biogas yield (SBY) from preliminary studies of the VMW samples collected during May month varied from 260 to 520 ml biogas g⁻¹ VS. While vegetable waste showed the highest SBY of 520 ml g⁻¹ VS and fruit waste yielded the lowest value with 260 ml g⁻¹ VS.

The specific biogas yield (SBY) of the VMW samples collected during November –December month varied from 150 to 250 ml biogas g-1 VS. While mixed VMW showed the highest SBY of 287 ml g-1 VS added. The VS reductions of 40.8%, 35.2%, 37.2%, 53.8% and 42.8% were observed for vegetable, fruit, flower, mixed vegetable and mixed slaughterhouse wastes respectively.

In February and March 2017, the process design and dimensions of the pilot plant was finalized. The pilot plant is designed to co-treat approx. 500 -1000 kg of substrate per day, comprising 65-75% VMW per day and 25-35% kg of SHW per day to represent the co-digestion ratios of 1:2 and 1:3.

In April 2017, a Thermogravimetry Analyser (TGA) with coupled Fourier Transformation Infrared Spectrometer (FTIR) was delivered to ISAH. In the same month, a Laboratory Extruder of LEHMANN-UMT was delivered to ISAH. In May 2017, both units were set up and tested. For the initial tests with the Laboratory Extruder, fibrous vegetable waste (i.e., Banana Peduncle) was imported from KMWC in Chennai by cold storage airfreight.

Publications

Conference

- Dhanalakshmi Sridevi, S. Porselvam, S. V. Srinivasan, "BMP studies on Flower wastes in Anaerobic Digestion process", 6th International conference on Solid waste Management organized by Jadavpur University, Kolkata under ISWMAW during November 24-26, 2016
- V.Mozhiarasi, Rinu Thomas, S.V.Srinivasan, R.Suthanthararajan, "Effect of Co-digestion on the Biogas production from Mixed Vegetable, Fruit and Flower (MVFF) waste with protein rich waste", International Conference on Integrated Solid Waste Management Practices in Developing Countries, organized by CSIR-NEERI, Nagpur, April 11-12, 2017.
- R.Nishanthi, V.Mozhiarasi, S.V.Srinivasan, S.Amal Raj, R.Suthanthararajan, "Anaerobic Digestion of Fish market Waste with Vegetable market waste", International Conference on Integrated Solid Waste

Management Practices in Developing Countries", organized by CSIR-NEERI, Nagpur, April 11-12, 2017.

Dissertations & Theses

- Rahul Ravi, Master Thesis, Topic: Investigation of Co-digestion of veg-market and slaughterhouse waste in Chennai, India (finalized)
- Leandra Drewes, Seminar Thesis, Topic: Comparative Analysis of Potential Applications for By-Products from Slaughterhouses (finalized)
- Mohammed Aslam, Bachelor Thesis, Topic: Life-Cycle Assessment of environmental impact reduction for Vegetable and Slaughterhouse Wastes through anaerobic digestion in Chennai, India (in preparation)
- Christopher Speier, PhD Thesis, Topic: Integrated Sustainable Systems for Organic Waste Management in India (working title)

Website

<https://www.isah.uni-hannover.de/254.html?&L=1>



S V Srinivasan
Central Leather Research Institute
Chennai



M Goutham reddy
Ramky Enviro Engineers Pvt Ltd
Chennai



Dirk Weichgrebe
Gottfried Wilhelm Leibniz Univ
Hannover



Thilo Lehmann
Lehmann GmbH
Pohl



SeNaMeB

Design of selective nanoporous membrane bioreactor for efficient production of bio-butanol from lignocellulosic sugars

Objectives

Butanol is a liquid of high energy density comparable to gasoline. Bio-butanol is made from renewables and CO₂-neutral. The production of bio-butanol from lignocellulosic waste materials is hindered by the low efficiency of the process chain what will be overcome in the project.

Aim of the project is the development of a novel membrane bioreactor for the efficient synthesis of bio-butanol from lignocellulose containing raw materials. A novel nanoporous membrane for continuous butanol separation will be developed and integrated in a new developed two-step bioreactor. The direct combination of a nanoporous membrane with the two step fermentation process will allow an energy and cost efficient butanol production from lignocellulose containing raw materials

A fluidized bed reactor (FBR) with immobilized *Lactobacillus* spp. on Ca-alginate beads is used for continuous lactic acid production. The lactic acid formed in this continuous operation is diluted and feed to *Clostridium* spp. for butanol production.

A nanoporous butanol selective membranes made of hydrophobic zeolites (Silicalite) is developed and will be directly combined with the fermentation for continuous butanol separation by pervaporation at low temperature.

The integration of the novel membrane with high butanol/water selectivity and high butanol permeance with the bioreactor (fermenter) will enable: (1) continuous recovery of butanol from bioreactor thereby giving butanol production at higher rate without inhibition or toxic effects on the metabolizing cells, and (2) continuous upgrading of butanol from low concentration broth of < 1 wt% to > 8 wt% (the boundary solubility of butanol in water).

The direct combination of the new membrane technology with continuous FBR based fermentation is allowing energy and cost efficient butanol production. It opens the opportunity of using sugar derived from lignocellulosic agricultural residues for sustainable and economic 2nd generation bio fuels.

Progress made/achieved

The lab scale membrane development for ceramic supported MFI-membranes as well as for mixed-matrix membranes was successfully finished in 2015 (see progress report 2015). The activities in the reporting period were mainly focused on the development of membrane preparation in an enlarged scale.

Atech prepared ceramic supports in a length of 0.5 m in single, 7- and 19-channel geometry. All supports were proceeded in an autoclave of a length of 800 mm to prepare MFI-membranes. In pervaporation tests up to 40 wt% butanol could be separated from 5 wt% solution giving evidence of an successful membrane preparation inside the enlarged geometries.



Fig. 1: Ceramic supports of 0.5 m length in single, 7 and 19 channel geometry developed by Atech (left) and 800 mm long autoclave for MFI-membrane synthesis (right)

For the mixed-matrix-membranes step-by-step the method for continuous preparation on a tape-casting machine was developed. Finally, several meters of mixed-matrix-membranes were prepared continuously in one batch and coiled up at the end of the machine.



Fig. 2: Front side of the tape-casting machine (left) and knife during casting the transparent support tape with a PDMS/MFI-mixture (right)

The membrane tape was cut in pieces of at least 500 mm. A small membrane sample was tested in butanol/water-separation at only 30°C. Because of the low temperature a very low flux but still a quite high selectivity was detected. High concentrated butanol could be separated from low concentrated solutions and the butanol content in feed solution was reduced by the membrane down to 0.2 wt%.

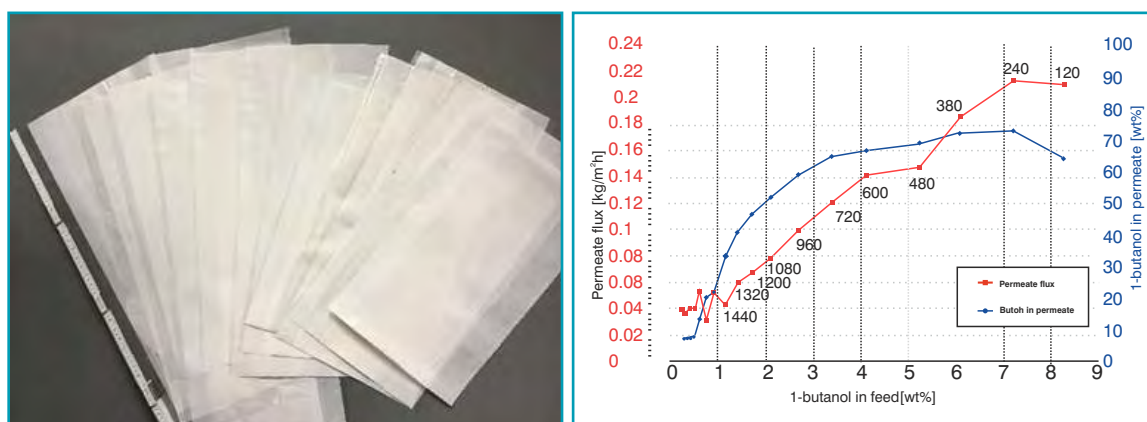


Fig. 3: Cut mixed-matrix-sheets (left) and PV-test @ 30°C (right)

Finally, a stack module with 13 membrane chambers was constructed, build up and tested. The stack module contains approximately 1 m² of hydrophobic mixed-matrix-membranes.

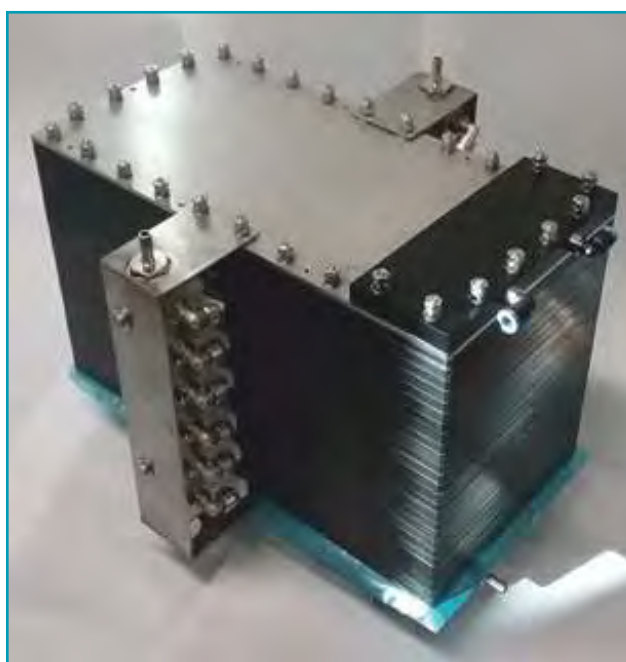


Fig. 4: Membrane stack of app. 1 m² membrane area for hydrophobic mixed-matrix-membranes

In addition to the planned project work Atech also developed porous ceramic tubes for the preparation of hydrophilic zeolite membranes. Support tubes of different pore sizes (Al₂O₃ 8 μm, MF10Z (ZrO₂ 100nm), UF100kDZ (ZrO₂ 100kD) and UF5kDZ (ZrO₂ 5kD)) were prepared, delivered and coated with zeolite FAU and zeolite A-membranes. The membranes were tested for the separation of water from concentrated butanol streams. A very high flux of > 15 kg/(m²h) and high water/butanol-selectivity of > 100 were achieved with the FAU-membranes on a 5kD-support. Very best results with a perfect water/butanol-selectivity of up to 300,000 were achieved with NaA on the 8 μm support. Practically butanol was dewatered from 4 wt% down to 0.5 wt%. Always nearly pure water of > 99.9wt% permeates through the membrane. Both types of membrane can be used for the absolutation of the concentrated butanol stream and in case of NaA-membranes without any loss of butanol.

Publications

Journals/Books/Book Chapters /Conference Papers /Presentations/Other Publications

H. Richter, M. Weyd, J.-Th. Kühnert, N. Reger-Wagner, I. Voigt, A. Michaelis Alumina and other ceramics in membrane and filter application, International Conference on Alumina and Other Functional Ceramics“ (AOFC-2017), February 15-17, 2017, Kolkata, India, Proceedings

M. Villwock, Th. Hoyer, H. Richter, M. Stelter Study on Pervaporation Properties of ceramic Silicalite and Silicalite-Alkylpolysiloxane composite Membranes, 29th German Zeolite Conference, March 1-3, 2017, Frankfurt/M., Proceedings

M. Villwock, H. Richter, M. Stelter Organophilic pervaporation properties of silicalite/polyalkylsiloxan composite membranes and its scale-up, Annual Meeting of ProcessNet group membrane technology, March 6-10, 2017, Köln, Proceedings

Presentation on

- Hannover Messe Industrie 25.-29.04.2016 | • AchemAsia, Beijing, 09.-12.05.2016
- Chemtech Mumbai 13.-18.02.2017 | • Hannover Messe Industrie 24.-28.04.2017

Meetings/Conferences/Networking Events

Project meeting in Mumbai during Chemtech 13.-18.02.2017

Continuous preparation of hydrophobic Mixed-Matrix-Membranes Stack module with app. 1 m² hydrophobic Mixed-Matrix-Membrane for butanol/water-separation



Arvind Mallinath Lali
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Sanjeev G Patil
Privi Biotechnologies Pvt. Ltd.
Navi Mumbai



H. Richter
Fraunhofer – IKTS
Dresden



P. Mund
Atech Innovations GmbH
Gladbeck



SIBAC

Next-generation dynamic scheimpflug imaging and biomechanical analytics for in vivo quantification of corneal viscoelasticity

Objectives

- Development of faster imaging sensor and location-specific measurement of corneal biomechanics using a non-contact air-puff technique
- Development of software package for real time parallel simulation using inverse finite element technique to estimate non-linear fiber dependent viscoelastic properties of the corneal tissue from deformation measurements of the cornea
- Combine the tools [aims (1) and (2)] into a clinical prototype that will be assessed in groups of patients with normal eyes (pre/post refractive surgery and ocular hypertension) and degenerative eye disease, namely keratoconus, and assess its sensitivity to treatments (collagen crosslinking)

Progress made/achieved

Major Activities

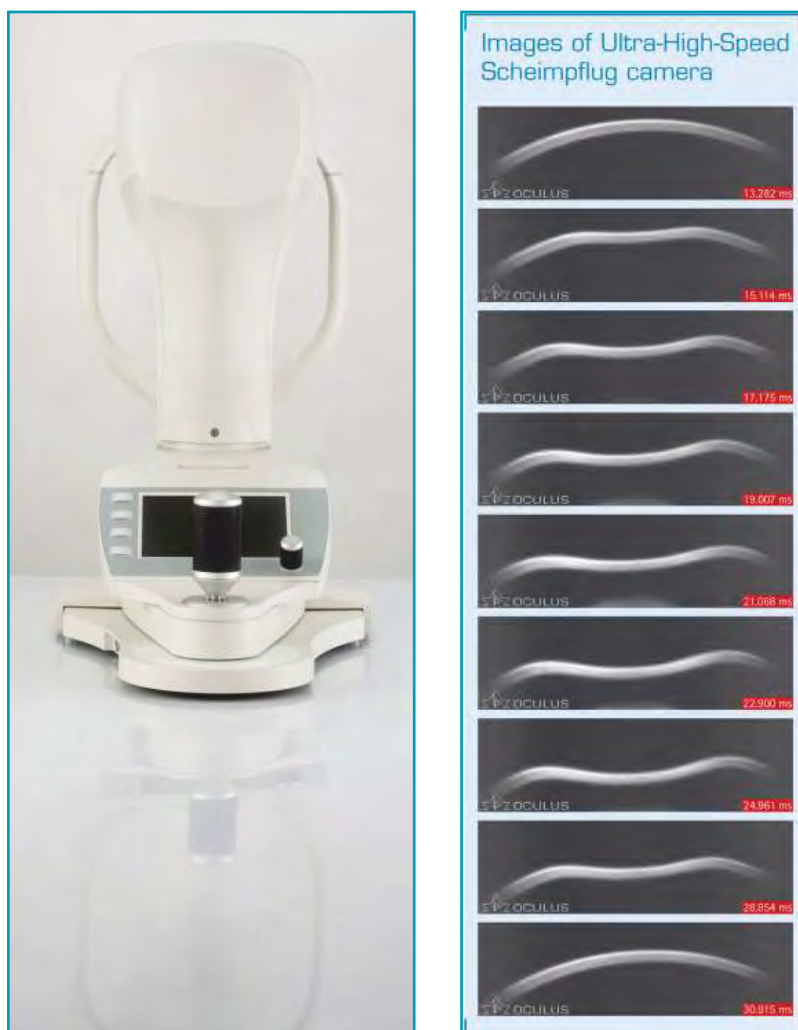
Oculus Optikgeraete GmbH

- Finalizing of a prototype with different fixation targets. First measurements with this prototype have been performed and analyzed. The diagram in section 3 shows the distribution of biomechanical response parameter in dependency of fixation. It proves the concept that up fixation (inferior measurement) reveals softer biomechanical properties than down fixation (superior measurement) as the cone of a keratoconus is usually located inferior.
- Development of an auto-tracking system that enables an automatic movement of the measurement head to the measurement position. This is required to ensure an user-independent accurate measurement at the correct alignment position which is especially important to measure the asymmetry between inferior and superior alignment position.
- Development of the camera system with higher time resolution. These steps require 1) adjustment of the optical system 2) new electronics and firmware for data processing. This work is currently in process and will be finalized in order to get a prototype at the end of the third quarter 2017.

Dresdner Group

- Installation of the device for measuring the intraocular pressure for experimental tests at porcine eyes (Installation of software (Mess-PC, Treiber, Steuerungssoftware, medizinische Statistiksoftware (Medcalc)), building of the experimental equipment, calibration of the pressure sensor by means of a water column.

- Clinical pilot studies (approved by ethical committee no EK 91032013) (Optimization of the measuring process at Corvis, Investigation of reproducibility of the new biomechanical parameters (Corvis ST) in keratoconus patients).



Indian Group

- First prototype of location specific biomechanical measurement of instrument built and undergoing design improvement. Preliminary testing on living human eyes performed to evaluate safety.
- Inverse finite element model (FEM) for LASIK and SMILE constructed. A prospective study on contra-lateral treatment was completed and data analyses are ongoing. The objective of this study was to develop the inverse finite element structure for future studies with new version of the biomechanical testing of the device. Biomechanical measurements were performed with the 1st generation of the instrument. A publication on some of the study results has also come out in Translational vision science and technology (doi:10.1167/tvst.5.5.12).
- State of the art image algorithms have been developed for 3-D reconstruction of topography of corneal layers from high resolution Optical coherence tomography (DRI Triton, Topcon Inc., Japan) device funded by SIBAC. This will be used for future FEM simulations.

Specific Objectives

The new alignment system in order to measure deformation response in different sectional planes was developed according to the plan. First clinical tests on keratoconus patients and patients with early inferior keratoconus have been performed.

The development of an auto-tracking system was not specifically mentioned in the proposal but the first tests have shown that the exact finding of the measurement position can be improved if the instrument moves automatically to the correct position and starts the measurement automatically. This insures a very high repeatability and user-independency.

According to the plan the architecture and design study of the new sensor has been finished. Currently, the optics of the camera system is adjusted to the new sensor and the data processing is optimized based on the new system. This work will be finalized according to the plan within 3. Quarter 2017.

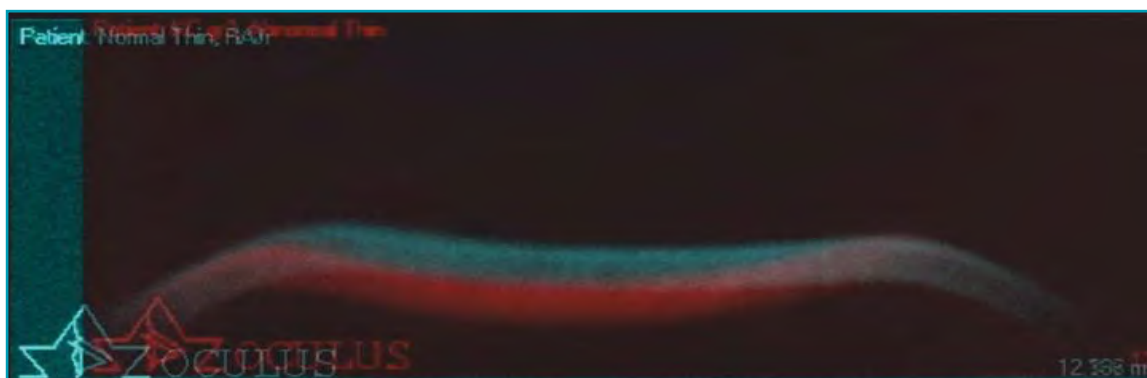
Installation of the device for measuring the intraocular pressure for experimental tests at porcine eyes

- Installation of software (Mess-PC, Treiber Steuerungssoftware, medizinische Statistiksoftware (Medcalc))
- Building of the experimental equipment
- Calibration of the pressure sensor by means of a water column

Clinical pilot studies (approved by ethical committee no EK 91032013)

- Optimization of the measuring process at Corvis
- Investigation of reproducibility of the new biomechanical parameters (Corvis ST) in keratoconus patients





Publications

Journals/Books/Book Chapters /Conference Papers /Presentations/Other Publications

- Shroff R, Francis M, Pahuja N, Veeboy L, Shetty R, Sinha Roy A. Quantitative Evaluation of Microdistortions in Bowman's Layer and Corneal Deformation after Small Incision Lenticule Extraction. Transl Vis Sci Technol. 2016; 5(5): 12.
- Matalia H, Francis M, Gangil T, Chandapura RS, Kurian M, Shetty R, Nelson EJ, Sinha Roy A. Non-contact quantification of topography of anterior corneal surface and Bowman's layer with high speed OCT. Under final review in Journal of Refractive Surgery, November 2016.
- Francis M, Pahuja N, Shroff R, Gowda R, Matalia H, Shetty R, Nelson EJ, Sinha Roy. Waveform analyses of deformation amplitude and corneal deformation in normal, suspect and keratoconus eyes. Under final review in Journal of Cataract and Refractive Surgery, November 2016.

Patents

- S. Roy, R. Shetty, and B. Shetty, "An index for quantification of bowman's layer for diagnosis of disease and prognosis of treatments in human cornea," WO2017098424 A2, 2016.



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Sound4All

Re-engineering high-end audiometric devices for robust and affordable audiological testing

Objectives

- **Background:** Hearing impairment is widespread in countries like India, especially in rural areas. Early detection of hearing loss is prerequisite for treatment and child development. Regular screening programs, trained medical personnel and medical equipment are not sufficiently available because of high equipment costs and the lack of trained manpower.
- **Goals:** This project aims to develop a hearing screening technology that can be used by laypersons and uses equipment that is very affordable, so that hearing screening can be done at primary schools by school teachers or at small primary healthcare centers in villages.
- **Technology:** We use Otoacoustic emissions (OAE) as the base technique, which allows objective testing, need little preparation, and can even be used on newborns. This procedure is widely used in clinics today, but the associated equipment is currently very expensive. The penetration of smart phones is very high, even in developing countries like India. This project investigates the use of lower cost electronics and compensating the resulting loss in accuracy by using more sophisticated signal processing algorithms that are implemented on smartphones.

Progress made/achieved

The first year of the project was used for knowledge transfer between partners and identifying the potential solutions that the project will pursue. First specifications for the ear-probe and the prototype device have already been developed.

Specific Objectives

- Ear canal volume study at AIIMS
- Ear probe prototypes printed and evaluated
- Development of test environments for the ear-probes and other hardware/software components
- Identification of hardware components for use in prototype device
- Market research on probe material, shapes and available device



Progress made/achieved

- Sound4All: Towards affordable large-scale hearing screening, Nils Heitmann, Philipp Kindt, Thomas Rosner, Kapil Sikka, Amit Chirom, Dinesh Kalyanasundaram, Samarjit Chakraborty. 12th IEEE International Conference on Design & Technology of Integrated Systems in Nanoscale Era (DTIS), 2017
- **Websites:** <http://www.rcs.ei.tum.de/en/research/sound4all/>

Meetings/Conferences/Networking Events

May 2016, Delhi

First meeting in Delhi to discuss initial tasks and probe measurements.

June 2016, Munich

In this meeting, which most of the project partners were able to attend, detailed knowledge on otoacoustic probe design was transferred. Also the first prototype probe design was drafted. The workshop in December was planned and a Munich ENT clinic (Klinikum rechts der Isar) was visited.

September 2016, Delhi

Details of our prototype probe and device were discussed and specified. First 3D printed prototypes were assembled and measured. Based on the results, next steps were defined.

February 2017, Mumbai

Meeting between Elkon, IIT Delhi and TUM to discuss Elkon work packages: Market research of existing devices, possibilities for injection molding and also ear tip manufacturing.

Conference attended

DTIS 2017 by Nils Heitmann, TUM At this conference "Sound4All: Towards affordable large-scale hearing screening" was presented.

Networking events held in India or Germany

December 2016, Delhi: AIIMS Sound4All workshop

This workshop was held to present and discuss the project to the project with the public including ENT doctors, audiologists and students. Basics of audiometry (OAE, ABR), hearing aids and algorithms were presented. This event was covered by Indian national TV and newspapers.



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New Delhi



Kapil Sikka
AIIMS
New Delhi



Amit Chirom
AIIMS
New Delhi



Suyash Ojha
Elkon India
Mumbai



Samarjit Chakraborty
TU Munich
Munich



Thomas Rosner
PATH Medical GmbH
Germering



WATERCHIP

DNA biochip for on-site water pathogen detection including viability and antibiotic resistance testing

Objectives

This proposal focuses on a multiplexed chip by adapting an already developed robust and low cost platform (Gene-Z) for on-site water pathogen detection. Genetic markers associated with at least a dozen waterborne pathogens, indicators, and antibiotic resistance bacteria are included on the chip including viability testing to be validated with appropriate sensitivity and specificity. The proposed project has three objectives:

- Provision of waterborne pathogens chips and detection systems
- Integration of live vs. dead (viability) protocol on the chip
- Field validation, deployment, support and feedback.

When fully developed and validated, the chip and platform will provide the a number of key benefits compared to other existing technologies and approaches including fast results, ease of use, specificity, sensitivity, and low cost. Differentiating characteristic compared to other molecular biology technologies include multiplexing of bacteria and protozoan, use of multiple virulence markers, live vs. dead differentiation, and measurement of antibiotic resistance genes. The consortium combines academic and industry partners with expertise in molecular biology, bioanalytics, and on-site detection technology development.

Progress made/achieved

- Provision of waterborne pathogens chips and detection systems

The novel GeneZ PLUS platform is under construction with new PCBs, their testing, assembly, design of mold for enclosure and two other internal components, and the associated controls (App and PCB programming and testing). Additionally functionalities were planned.

- Integration of live vs. dead (viability) protocol on the chip

Several dyes for live/death differentiation were selected and tested.

- Field validation, deployment, support and feedback

Protocols and primer sets for LAMP based detection for different water-related microorganisms and ARGs were designed and tested. Protocols with different parameters were investigated and partially optimized for point-of-care potential. Model systems and several real-samples were tested.

Specific Objectives

Objectives with respect to project partner in progress are as follows:

Protocols for AR gene detection (Ahmedabad University)

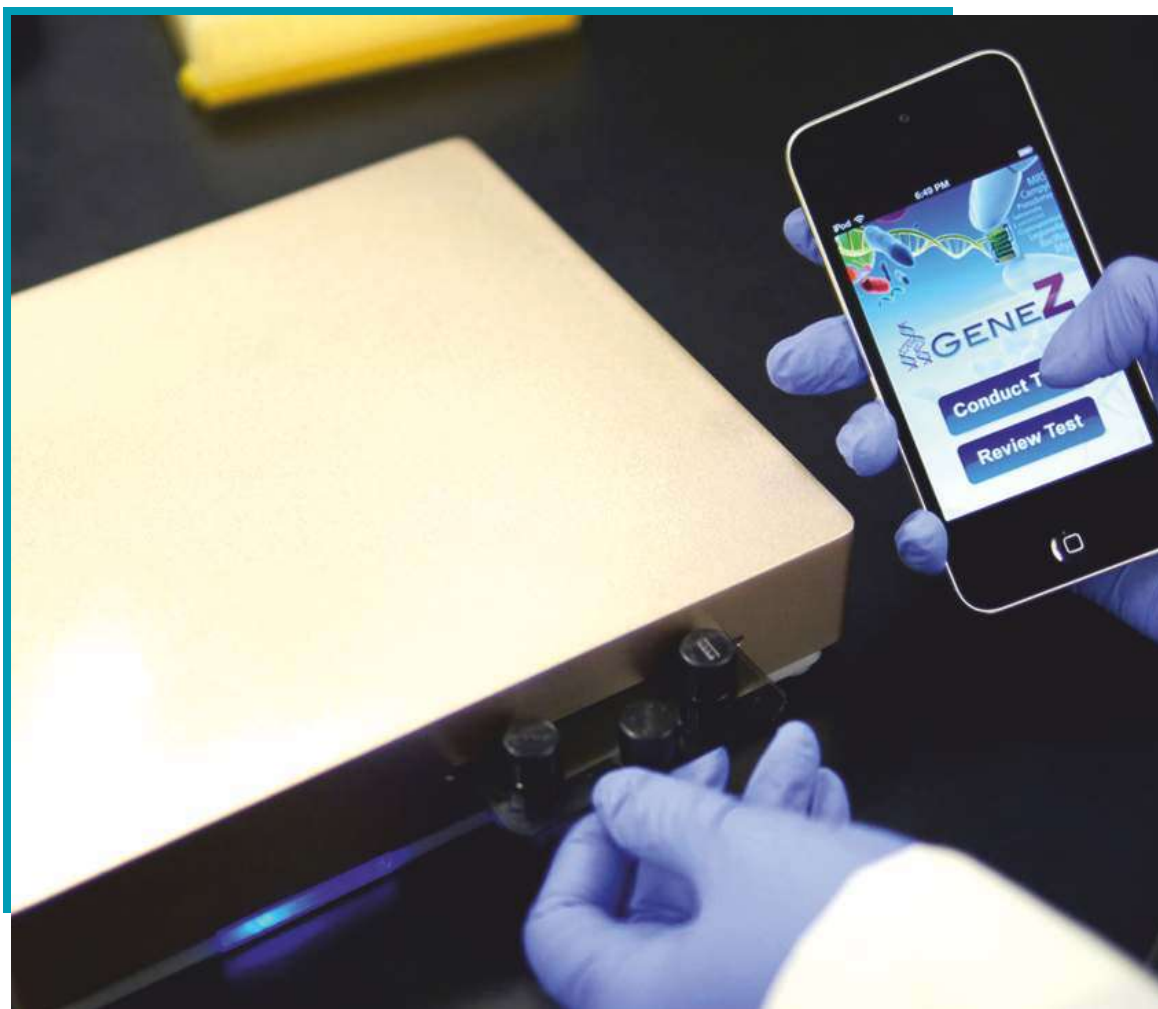
- Primer design
- Establishment of amplification protocol
- Testing and optimization

Development of cell viability assay (IPHT/AU)

- Protocol establishment
- Testing
- Optimization

Provision of Gene-Z platform (ABC Genomics)

- Production of Gene-Z as well as cartridges
- Provision of a Gene-Z platform per partner
- Delivery of cartridges for partners
- Development of adapted cartridges for viability tests



Key outcomes or any other achievements:

A set of primers for LAMP for pathogens were designed: *E.coli*, *Shigella* spp., *Legionella pneumophila*, *Cryptosporidium parvum*, *Giardia intestinalis*.

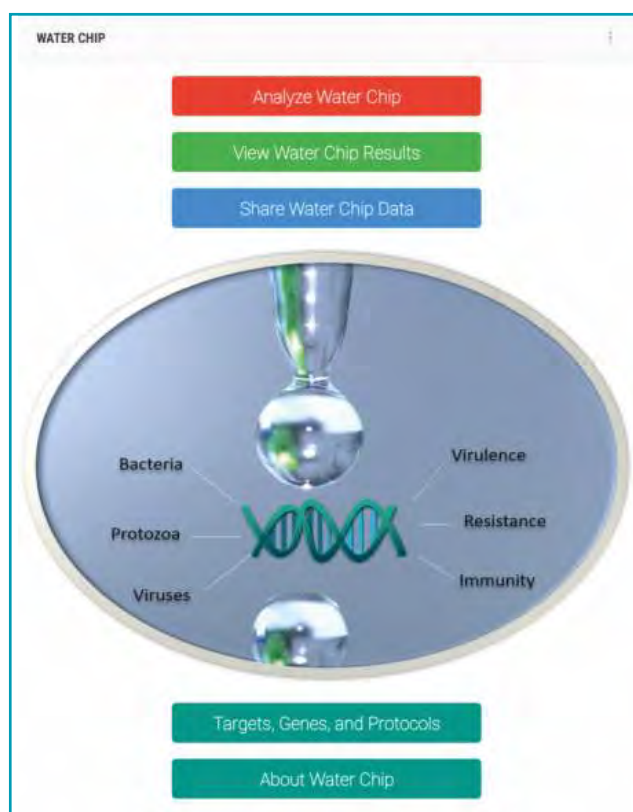
A set of primers for LAMP for ARGs were designed and some tested: Carbapenem KPC and NDM, Tetracycline

Model system for LAMP in table cycloer for future validation were established

Several LAMP protocols for pathogens were tested with real surface water

The GeneZ device is optimized for better manufacturability using single PCB

App is in development



Publications

Journals/Books/Book Chapters /Conference Papers /Presentations/Other Publications

Kosman, J.; Jatschka, J.; Csaki, A.; Fritzsche, W.; Juskowiak, B.; Stranik, O. A New Strategy for Silver Deposition on Au Nanoparticles with the Use of Peroxidase-Mimicking DNAzyme Monitored via a Localized Surface Plasmon Resonance Technique Sensors 2017, 17, (4), 849.

Websites

<http://waterchip.eu/>

Meetings/Conferences/Networking Events



WATERCHIP



Rishi Shanker
Ahmedabad University
Ahmedabad



Ashutosh Kumar
Ahmedabad University
Ahmedabad



Somesh Mehra
ABC Genomics (India) Pvt. Ltd
Lucknow



Wolfgang Fritzsche
Leibniz Institute of Photonic Technology
Jena



Bernd Giese
Food GmbH Jena
Jena







WORKSHOPS/SYMPOSIA

INDO-GERMAN SYMPOSIUM “SMART CITIES: CHALLENGES & OPPORTUNITIES”

Indo-German Science & Technology Centre (IGSTC) organised a symposium on “Smart Cities: Challenges & Opportunities” in association with FICCI (India), Nexus Institute (Germany) and PTV AG (Germany). The three day event from 27-29 April, 2016 included presentations, working groups panel discussions and field trips covering the areas of Energy and Buildings, Mobility and Management, Waste Management and Sanitation, Water, Communication – Safety – Security in respect to Smart cities. The event was graced by Indian and German academicians, scientists, industrialists and policy makers.

The event was inaugurated by Parliamentary State Secretary Rachel and the Indian Ambassador Mr. Singh commenting on the political strategies of both countries – especially the two initiatives “100 Smart Cities” and “Zukunftsstadt”.



Panel discussions on the following topics were held from 27-29 April, 2016:

**Energy and
Buildings**

**Mobility and
Management**

**Waste Management
and Sanitation,**

**Communication –
Safety – Security**

Water

The discussions were informative, enthusiastic with the participants from diverse backgrounds of science and technology bringing their expertise and experience working in the field of smart cities to the fore. Speaker took a holistic view of particular topics discussing the issues, challenges, opportunities, threats & possible solutions. They also explored the projects and opportunities related to Indo-German partnership within the realm of topics pertaining to Smart cities. This report gives a brief summary of discussions held in the course of symposium.

Overall conclusions

1

Research should emphasize on adaption of existing solutions.

2

Participation of the public will be a key factor in converting a city into a smart city. Therefore programs have to be established to educate the public.

Panel Discussion Waste Management and Sanitation

Waste management and Sanitation is one of the most plaguing issue related to India and Germany. Hence a systematic and organized approach to this is needed to make a Smart City project in India successful. Panel started with discussing pressing issues related to Waste Management and Sanitation. In India some of the issues which were dwelled on are i.e. the amount of waste, informal sector of rag pickers, no proper segregation of waste at source, no proper business model and lack of motivation from companies in this sector. The challenges facing the sector are varied demography, tropical climate, public awareness, governance and responsibilities of the stakeholders as well as non-implementation of existing regulations, lack of sufficient investment in proper Infrastructure, trust deficit in business and Government bodies. The challenges and issues pose a great opportunity for technology, markets and business. New markets and technologies must be developed. For instance there is a vast market for Biogas & Waste2Energy technologies. Some of the solutions discussed were waste segregation at source and proper collection systems. This has to be combined with transfer stations with modern technologies and machineries and has to go along with capacity building and training, including innovative technologies that suit India's requirement to educate the masses. Research is needed to develop and to adjust existing solutions. Best practices needs to be shared. Participants concluded the discussion that more investment is needed. But first of all the attitude in people has to change. Germany's waste segregation system could be adopted to the Indian requirements.



Panel Discussion Water

Water is the key ingredient for life and as such sustains pretty much everything on earth for life to thrive. Climate change, scant fresh water resources makes the planning for utilizing water of utmost importance and prudence. Water networks are the veins and arteries of a city. The key issues related to water discussed were Integrated and sustainable water management techniques, and affordability. But water has to have a price so that people value water and do not waste it. Availability and intelligent technology for water supply is another important field.

Resource mapping and study of the existing system using soft computing techniques is needed. This can be supported by GIS and remote sensing tools. Smart Cities will need efficient monitoring system of water distribution networks as well as smart water distribution systems. The challenges posed are leakage detection, monitoring and testing system. This has to be combined with a fair price system, where intelligent meters can be of great help. Research needs to address real sustainable technology, enforcing accountability and good water pricing. The development of zero waste and zero wastewater house/community should be one goal in building a Smart City. Participants discussed water governance considering planning, actors involved as well as management & maintenance. Integrated and inclusive planning according to local conditions has to be identified. Business models should integrate all important stakeholder from active and applied research, development organizations, industry and universities. Good governance approaches should be developed that find a way to balance between different actors in the field in order to supply safe and affordable water to all actors. Regulation will play an important role in successful execution and implementation of various water-related activities like water safety and quality, water conservation, water balancing, water management in agriculture through regulation and enforcement etc.



Panel Discussion Energy and Buildings

Buildings are the main energy guzzlers of any city. Smart integration of energy and building management system will truly result in making a city smart. Conversations started with discussing issues such as lack of awareness and willingness to change, high grid losses/technical losses/theft related losses. Ghost towns, strict laws in the field of energy & building were also discussed. Solutions presented by the panelists were better regulations and policies, updating age-old standards to bring positive and sustainable changes in energy usage and savings. Another area discussed was to bring change in user behavior from consumer to prosumer. Integrated supply- (power plants/distribution) and demand-side (consumers) management effectively would also make smart use of energy. Research in Pilot projects, learning from experiences/mistakes from German peers and avoiding similar mistakes would help in finding innovative and creative solutions for energy-efficient buildings. Panelists also discussed raising energy saving and conservation to mass levels, awareness about cost-benefits for using various renewable energy technologies in Indian context.

Panel Discussion Mobility & Management

Mobility and transportation is what drives the economics of city and touches many aspects such as people, goods, and services. Mobility & its management is integral to smart city. Issues discussed were poorly maintained and fragmented transport facilities, negligence of urban freight transport and logistics. First and last mile connectivity, lack of coordination among various departments in preparation and implementation of transportation plans were also discussed. Challenges faced in mobility are creating reliable, accurate and accessible database for preparation and evaluation of transportation plans. Some of the other challenges looked upon were establishing comprehensive traffic management centers, changing commuter behavioural patterns to accept and choose walking, cycling and public transit for their day to day travel, maintenance of continuous footpaths / cycle paths and protecting them from occupation/encroachments etc. Mobility and transport services present a hoards of opportunities like healthy competition among state governments / urban local bodies to transform their cities as smarter ones. Many joint research topics were also discussed like estimating public transit demand and scheduling for varied planning alternatives like compact city, sustainable city, transit oriented development, multimodal transport, mixed land use, integration of land use and transport, etc with emphasis on energy conservation., First and last mile connectivity; developing evaluation procedures including micro-simulation for testing various traffic and transportation plans / proposals, traffic impact analysis, etc were some of the solutinos proposed. Panelists urged to emulate German success stories with respect to indian context as done in making Berlin a smart city.



Panel Discussion Security and Communication

Security and communication assumes a major role in today's hyper-connected world. Good communication networks and security architecture will be backbone of smart cities. It will touch each and every aspect of Smart city. Discussions focused on planning to have relevant data with respect to traffic, water etc. Planning needs to be done on automatisisation of processes which are continuously increasing in response to lack of capacity. Confidence building measures needs to be taken to win trust (or lack of it) of citizens in government, reliability of systems, consent around personal data .Open standards and modular approaches for communication will pave a way for sharing data among various stakeholders in the city. Panelists concluded the session with emphasizing research on data, opportunities and risks of automation, trust & governance of infrastructure. Participants emphasized on better links between academia & implementation and how to improve the many governance deficits in both Germany & India.





DST-MAX PLANCK SOCIETY PROGRAMME

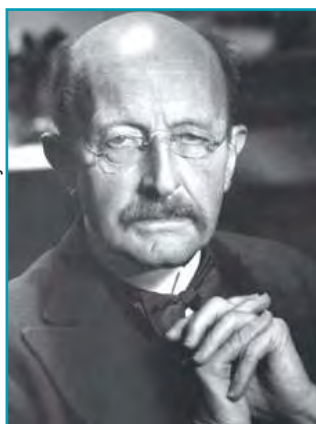
DST-Max Planck Society Programme Connecting Excellence



The Department of Science & Technology (DST), Govt. of India and Max Planck Society (MPG), Germany have collaborated, through an agreement signed in 2004, to constitute and operationalise DST-Max Planck Society Programme.

Running since year 2004, the DST-Max Planck Society Programme has two flagship initiatives under its umbrella aimed at creating opportunities for collaboration and sustained interactions with S&T research priorities.

IGSTC has been entrusted with the responsibility of implementing the DST/MPG Programme from Indian side.



Source : Max Planck Society

“Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery that we are trying to solve.”

Max Planck

Max Planck Partner Groups at Indian Institutes

The “Partner Group” is an instrument created by the Max Planck Society (MPG) for the purpose of strengthening the ties between Max Planck Institutes and research institutes from other countries. Partner Group is a mechanism to intensify cooperation between individual scientists through jointly conceptualized and implemented S&T research projects.

The “Max Planck Partner Group at Indian Partner Institute” has been developed as an instrument for supporting collaborative research in target areas prioritized on the basis of their relevance to immediate problems and interests of institutions involved from both sides.

Partner Groups are headed by Indian scientists who return to India after completing their extended research residency at a Max Planck Institute. Partner Groups allow the involved scientists to lead appropriately equipped research groups in order to continue their research activities in close co-operation with their former German hosts.

Each Partner Group is supported to the tune of €20000 per year by MPG with a matching contribution of equivalent amount by the DST. Grants are expected to be utilized, as far as possible, for the purpose of creating MPI like facilities at the respective Indian host institutions.

Structural Biology of vesicular trafficking: Screening of putative Rab5 GAPs for their role in Rab5 to Rab7 conversion



Sunando Datta
IISER Bhopal



Marino Zerial
MPI of Molecular Cell Biology
and Genetics, Dresden

Genetic Diversity Studies: Studies on human salivary microbiome in Indian populations and its implications in human genetic diversity studies, health sciences and evolutionary biology



Madhusudan Reddy
CDFD Hyderabad



Mark Stoneking
MPI for Evolutionary
Anthropology, Leipzig

Chemical Ecology: The role of small-RNA pathways in plant defense against insect herbivores



Shree Prakash Pandey
IISER Kolkata



Ian Thomas Baldwin,
MPI for Chemical Ecology,
Jena

Centre for cosmology and gravity



S. Shankaranarayanan
IISER Trivandrum



Hermann Nicolai
MPI for Gravitational Physics,
Potsdam

Asymmetric organocatalysis: New aminocatalytic asymmetric transformations



Subhas C Pan
IIT Guwahati



Benjamin List
MPI for Kohlenforschung
Muelheim an der Ruhr

Atmospheric Sciences: Characterising the properties of biological aerosol particles under different environmental and seasonal conditions over the Indian tropical region : assessment for possible climatic & health impacts



Dr. Sachin S Gunthe
IIT Madras



Prof. Ulrich Pöschl
MPI for Chemistry, Mainz

Regulation of RNA splicing by a novel ubiquitin related protein



Dr. Shravan K. Mishra
IISER Mohali



Prof. Stefan Jentsch
MPI of Biochemistry
Martinsried

Solar Physics: Coupling and dynamics of solar atmosphere



Dr Durgesh Tripathi
Inter-Univ Centre for Astronomy
and Astrophysics, Pune



Prof Sami K Solanki
MPI for Solar System
Research, Lindau

Role of cellular membranes in stress signalling and protein homeostasis maintenance



Dr Swasti Raychaudhuri
CSIR-CCMB Hyderabad



Prof F Ulrich Hartl
MPI of Biochemistry
Martinsried

Multifunctional hybrid nanostructures for alternative energy systems



Dr Amreesh Chandra
IIT Kharagpur



Prof Katharina Landfester
MPI for Polymer Research
Mainz

Visiting Fellowships/Mobility Grants

Max Planck-India Visiting Fellowship is a distinction for highly qualified and talented scientists. The Fellowship is awarded to scientifically outstanding, promising young Indian scientists.

Individuals selected for the award get the opportunity to work with Scientists at the Max Planck Institute (MPI) relevant to their area of expertise for up to 2 months a year for four consecutive years.

Fellowship holders receive from MPG a sum of € 3,000 per year, for up to four years, with Indian side providing travel support for each research stay.

S. No	Fellow	MPI Counterpart	Field of Research / Title
1	Dr Srinivasan Krishnamurthi Institute of Microbial Technology Chandigarh	Prof Bremen Rudolf Amann MPI for Marine Microbiology, Bremen	Polyphasic taxonomic characterization of marine bacteria and analyses of the microbial diversity in Indian marine waters using culture-independent approaches
2	Dr Suneel Kateria Delhi University, Delhi	Prof Wolfgang Gaertner MPI for Bioinorganic Chemistry, Mülheim	Deciphering the role of the flanking N- and C-terminal regions in the modulation of photocycle kinetics of a LOV domain of a marine algal phototropin
3	Dr Sandeep Kaur Delhi University, Delhi	Prof Matthias Stein MPI for Dynamics of complex technical systems, Magdeburg	Transition metal dithiolato complexes as functional models for hydrogenases
4	Dr Koushik Dutta IISER, Bhopal	Dr Georg G Raffelt MPI for Physics, München	Inflationary cosmology and its connection to particle physics
5	Dr Naveen Chandra Bisht NIPGR, New Delhi	Prof Jonathan Gershenzon MPI for Chemical Ecology, Jena	Investigating the role of glucosinolate content towards plant fitness in <i>Brassica juncea</i>
6	Dr Subbulakshmi Chidambaram Vision Research Foundation Chennai	Prof Reinhard Jahn MPI for Biophysical Chemistry, Goettingen	Dissecting the regulatory role of Adiponectin signalling in human retinal synaptic vesicle trafficking under physiological and pathological conditions
7	Dr P Anil Kumar Institute of Microbial Technology Chandigarh	Prof Friedrich Widdel MPI for Marine Microbiology, Bremen	Physiology of mixotrophic planktonic bacteria
8	Dr Satya Pal Nehra Deenbandhu Chhotu Ram Univ of Sci & Tech, Murthal	Prof Dwayne Miller MPI for Dynamics and Structure of Matters Hamburg	Preparation and Characterization of Semiconductor Photocatalysts for Surface Reaction Dynamics Study and their Applications
9	Dr Richa Rai Banaras Hindu University Varanasi	Prof Jonathan Gershenzon MPI for Chemical Ecology, Jena	Application of metabolite, transcript and flux measurements to investigate the effect of elevated ozone and carbon dioxide on yield and pest protection of C3 and C4 crops

10	Dr Kamal P Singh IISER Mohali	Prof J M Rost MPI for Physik Komplexer Systeme, Dresden	Sub-fs control of photo-dynamics in atoms/molecules using shaped XUV pulses
11	Dr N Ramesh Kumar NIIST, Thiruvananthapuram	Prof Ian Thomas Baldwin MPI for Chemical Ecology, Jena	Identification and functional characterization of seed borne bacterial endophytes of <i>Nicotiana attenuata</i> and the elucidation of their transmission to the progeny using culture-dependent and-independent approaches
12	Dr Areejit Samal Institute of Mathematical Sciences, Chennai	Prof Jürgen Jost MPI for Mathematics Sciences, Leipzig	Computational methods for identifying and analyzing design features of metabolic networks
13	Dr. Arjun Bagchi IISER, Pune	Prof Stefan Theisen Gravitational Physics, Golm	Minkowskian Holography
14	Dr V Pramitha IIT Madras	Prof Joachim P Spatz MPI for Intelligent Systems, Stuttgart	Direct patterning of vortex generating diffractive optical elements on fibre tip using a focused ion beam
15	Dr Karthik V Raman IISc Bangalore	Prof Klaus Kern MPI for Solid State Research, Stuttgart	Tailoring interface spin transport: towards molecular spintronics
16	Dr Srikant Sukumar IIT Bombay	Prof Peter Benner MPI for Dynamics of Complex Technical Systems, Magdeburg	Cooperative control and consensus, nonlinear control, adaptive control, time-varying systems
17	Dr K Sowjanya Sree Amity Univ, Noida	Prof David G Heckel MPI for Chemical Ecology, Jena	Transcriptional responses of <i>Helicoverpa armigera</i> to the insecticidal mycotoxin, Destruxin
18	Dr Venkat Gundabala IIT Bombay	Prof Katharina Landfester MPI for Polymer Research, Mainz	Water-based nanocomposite coatings
19	Dr Anshu Deenbandhu Chhotu Ram Univ Sci & Tech, Murthal, Sonapat	Prof R J Dwayne Miller MPI for the Structure and Dynamics of Matter, Hamburg	Structure and Dynamics of Functionalized and Catalysts Modified Carbon Nanotubes for Charge and Mass Transport Applications

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