

# A 2017 R E P O R T

**KIST** Europe  
Korea Institute of  
Science and Technology



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KIST Europe has recently stepped into 'adulthood' as it reached its 20th year in 2016. Since 1996 in Saarbrücken, KIST Europe has accomplished the mission of establishing a bridge for joint research between high-technology research institutes in Europe and Korea. All members at KIST Europe, from different nationalities and various backgrounds, have accomplished the ultimate mission by extending their capabilities and expertise.

# A 2017 ANNUAL REPORT

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**Planning and Coordination :**

Global Cooperation Department,  
KIST Europe Forschungsgesellschaft mbH

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# PREFACE

## Greeting of the Director



### Dear Readers,

KIST Europe has recently stepped into 'adulthood' as it reached its 20th year in 2016. Since 1996 in Saarbrücken, KIST Europe has accomplished the mission of establishing a bridge for joint research between high-technology research institutes in Europe and Korea. All members at KIST Europe, from different nationalities and various backgrounds, have accomplished the ultimate mission by extending their capabilities and expertise.

It is our pleasure to present our research activities and notable achievements in 2017. Our report will make evident our diverse collaborative efforts and specialized expertise in open and innovative research.

For any research institute or industrial organization currently searching for a competent partner for joint research, or for those planning to expand their business into Korean or European markets, KIST Europe is undoubtedly the most suitable collaboration partner to achieve their goals. It is our hope that you will recognize the significance of our role in science and technology partnerships between Korea and Europe.

I wish to acknowledge the consistent support and contribution from all of our collaboration partners, and to express my profound gratitude to the Saarland government and Saarland University for their enduring support and attention. I look forward to maintaining these partnerships to further expand our collaboration areas.

Finally, I wish to express my genuine appreciation for all members of KIST Europe for their notable efforts and contribution.

Sincerely,

**Dr. Junkyung Kim**  
Director, KIST Europe

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H

History with past & PRESENT

H i s t o r y

w i t h p a s t

&

P R E S E

N T



Korea Institute of  
Science and Technology



## HISTORY

The only government supported research institute in abroad with 21 years history

The official visit of the 14<sup>th</sup> Korean President KIM, Youngsam to Germany

Both governments agreed on the establishment of a Korean research institute organization within FhG.

1<sup>st</sup> building completion  
(providing 5,275 m<sup>2</sup> with 4 stories)

Facility : Laboratory, office, meeting room, lecture and conference room

2<sup>nd</sup> building completion  
(providing 2,069 m<sup>2</sup> with 3 stories)

Facility : 2 complex for office, Laboratory

Role : Providing facilities for local industries, academic institution and research organisation



1995 Mar

1996 Feb

2000 Apr

2006 Apr

2010 Apr

2016 May



### Foundation of KIST Europe

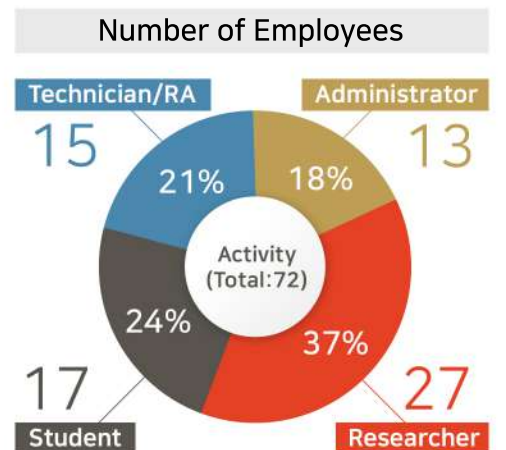
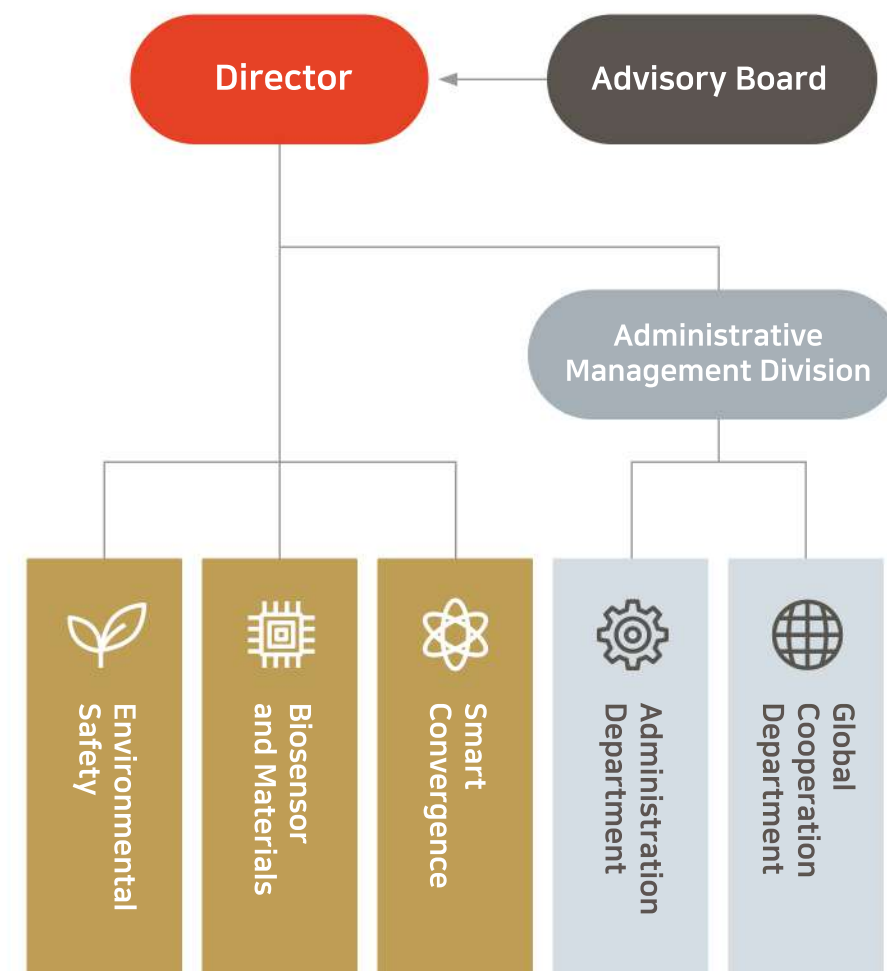
Role: Research on applied environmental & strategic technologies and channel for national cooperation

Classification of organization : Limited liability company with 1 sole member (President of KIST)

10<sup>th</sup> Anniversary

20<sup>th</sup> Anniversary

## ORGANIZATION & EMPLOYEES



## CONTACTS



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## VISION & STRATEGIES



### Vision

Becoming an Open Innovation Hub for R&D Collaboration and Industrial Activities

### Strategies

#### Open Research

Improve R&D Competence through Selective and Focused Strategy

- Develop platform technology for global environmental regulation compliance

#### Stimulate Joint R&D of Korea-EU

- Promote joint R&D of KIST and prominent research institutions in Korea with the EU (to allocate 35% of total R&D funds on joint R&D)



#### Industry Support

Support Korean Industry Activities in the EU

- Establish on-site technology centre, provide consultation for technology sourcing and organise an integrated partner network
- Support chemical regulation compliance for Korean chemical industry regarding REACH and REACH-like regulations

## ADVISORY BOARD MEMBERS



### Korean Members



**Dr. Byung Gwon Lee** (Chairman)

President,  
Korea Institute of Science and  
Technology



**Mr. Bohyon Jang**

Director General of the International  
Cooperation Bureau,  
Korean Ministry of Science and ICT



**Dr. You Seung Kim**

Former President of KIST,  
Korea Institute of Science and  
Technology



**Dr. Myung Soo Kim**

Former President of KRISS,  
Korea Research Institute of Standards  
and Science



**Dr. Lee Hwan Kim**

Executive Deputy Chairman,  
Korea Industrial Technology  
Association (KOITA)



### German Members



**Mr. Jürgen Lennartz**

Head of Saarland State Chancellery



**Prof. Dr. Manfred Schmitt**

President,  
University of Saarland



**Dr. Lothar Mennicken**

Director of the Cooperation with Asia  
and Oceania Division,  
German Federal Ministry of Education  
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**Prof. Dr. Wolfgang Wahlster**

President,  
German Research Centre for Artificial  
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**Prof. Dr. Andreas Schäffer**

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Managing Director,  
Helmholtz Institute for Pharmaceutical  
Research Saarland(HIPS)



R  
Research with PASSION

R e s e a r c h

w i t h

P A S S I O N



Korea Institute of  
Science and Technology





**Dr. Sanghun Kim**  
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# ENVIRONMENTAL SAFETY

## Objectives

Environmental Safety Group contributes to protection of human health and the environment from hazardous chemicals and mixtures of these chemicals, and to enhancing national competitiveness of chemical industry by fostering chemical trade and by ensuring high safety standards of the products.

## R&D Areas

### Alternative Toxicity & Ecotoxicity Assessments

- Investigation for the sources of origin and characterization of environmental pollutants and mixture
- Development of animal alternative test (AAT) system for chronic toxicity screening
- Development of environmental risk assessment tools and modeling

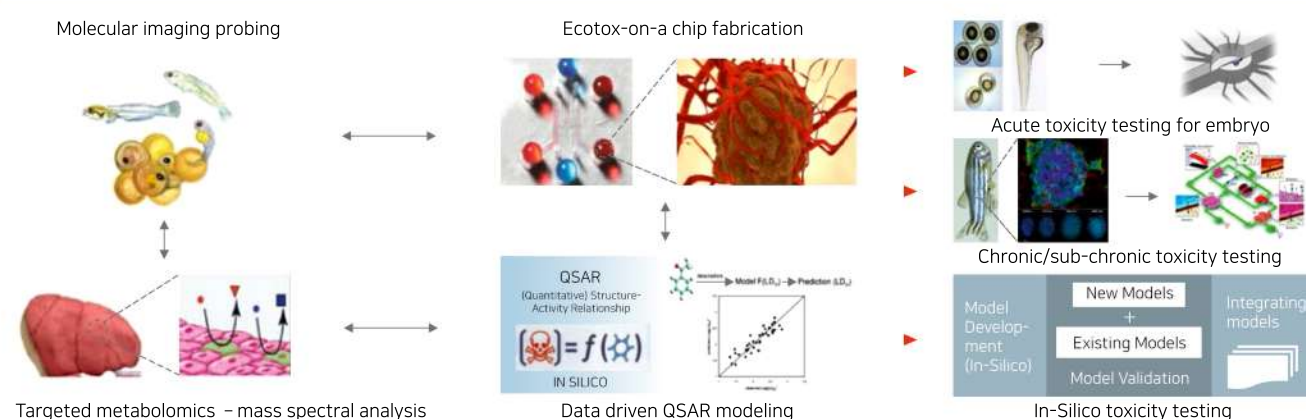
### Computational Toxicology

- Prediction of mixture toxicity using advanced computer models
- In-Silico approaches as an animal alternative test(AAT)

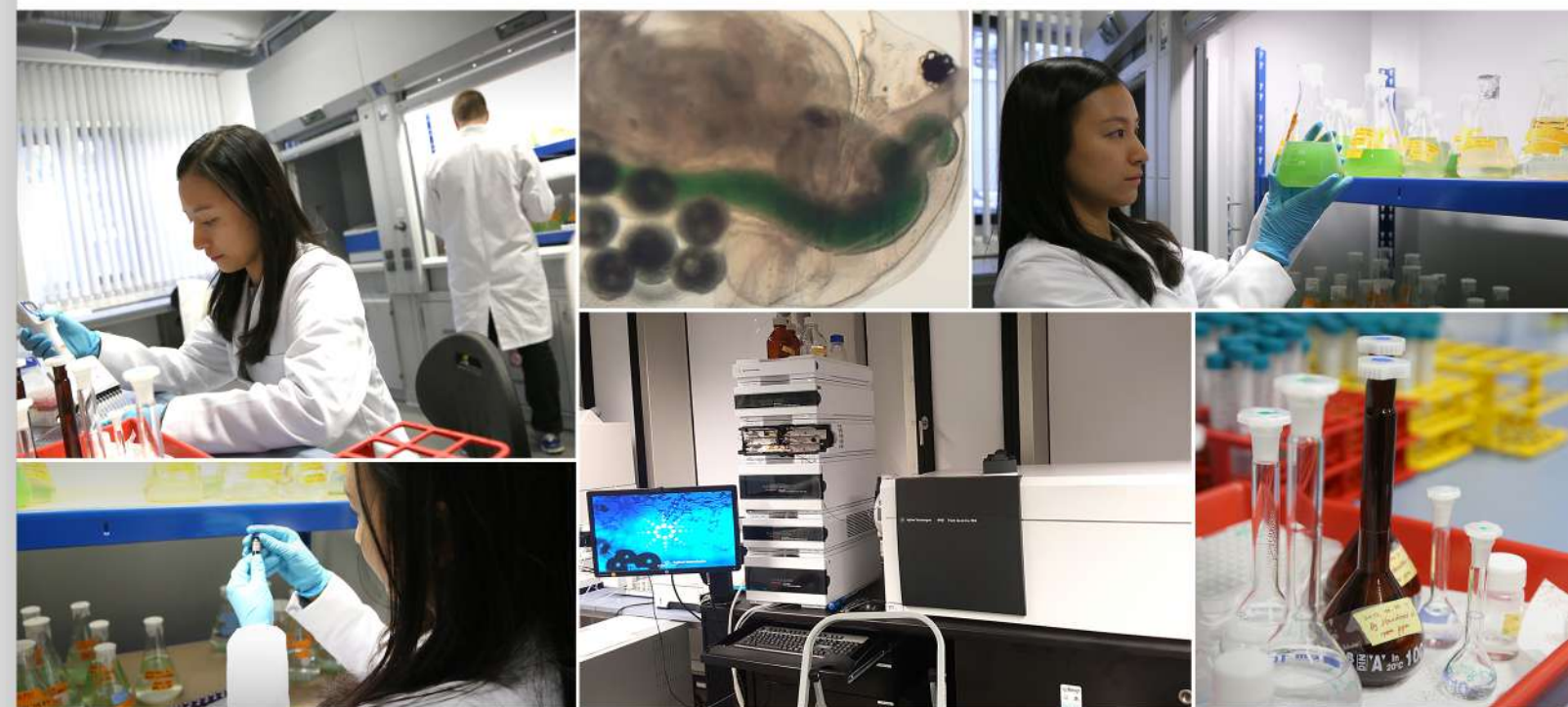
### Development of Metabolomics and its Application in Biomarker Discovery

- Targeted/pseudo-targeted metabolomics of chemicals
- Metabolomics in biomarker discovery
- Detection and quantification of metabolites and biomarkers

## Concept for research flow



# ACHIEVEMENTS 2017



## Journals

Omidi, A.; Esterhuizen-Londt, M.; Pflugmacher, S., "Still challenging: the ecological function of the cyanobacterial toxin microcystin - What we know so far", *Toxin Reviews*, 36, 1-19, (2017).

Park, C.-B.; Kim, Y.J.; Soyano K., "Effects of increasing temperature due to aquatic climate change on the self-fertility and the sexual development of the hermaphrodite fish", *Environmental Science and Pollution Research*, 24(2), 1484-1494, (2017).

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Eggers R.; Philippi A.; Altmeyer M.O.; Breinig F.; Schmitt M.J., "Primary T cells for mRNA-mediated immunotoxin delivery", Gene Therapy, 25(1), 47-53, (2017).

Spengler, A.; Wanninger, L.; Pflugmacher, S., "Oxidative stress mediated toxicity of TiO<sub>2</sub> nanoparticles after a concentration and time dependent exposure of the aquatic macrophyte *Hydrilla verticillata*", Aquatic Toxicology, 190, 32-39, (2017).

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J. Yang, H. Jeon, S. Song, S. Kim, "Compliance strategy for EU cosmetic regulation", EU Cosmetic Regulation Seminar (organized by Foundation of Korea Cosmetic Industry Institute)

O. Weiss, H. Hong, J. Yang, "Strategy for European Companies for K-REACH compliance", K-REACH Infoday, Cologne, 27.04.2017

O. Weiss, "K-REACH - Changes, Preparations, outlook", Steptoe Seminar on Global regulations, Brussels, 14.06.2017

O. Weiss, S. Song, "Overview of K-BRP", Chemical Watch Asia Hub Summit, Brussels, 18.09.2017

O. Weiss, S. Song, "Exhibitor on REACH, K-REACH and K-BRP compliance", Chemical Watch Asia Hub Summit, Singapore, 20.-23.11.2017

Jeong H., Kim J., "Data Integration and Gene Network Analysis for Identifying EDCs in Personal Care Products Associated with Breast Cancer", SETAC Europe 2017

Jeong H., Kim J., "A Case Study on Current Risk Characterization Methods for Occupational Exposure to Chemical Mixtures", SETAC Europe 2017

Kim J., Jeong H., Akhlaq, K., Kume, K., Kim Y.J., Kim S., "A Web-Based Integrated Platform for Mixture Risk Assessment Tools", SETAC Europe 2017

Kim J., "Prediction of Mixture Toxicity using Computational Toxicology Methods", 3rd BiKiE Symposium

Kim J., Fischer M., Helms V., "SynToxTool: Prediction of synergistic toxicity of mixtures by using chemical-protein and protein-protein networks", SETAC North America Focused Topic Meeting on Risk Assessment of Chemical Mixtures

Kim J., Kume, K., Jeong H., "MixToxDB Ver. 1.0: An online database on the toxicity of binary chemical mixtures to environment-living organisms", SETAC North America Focused Topic Meeting on Risk Assessment of Chemical Mixtures

Kim J., Jeong H., Akhlaq, K., Kume, K., Kim Y.J., Kim S., "A Web-Based Integrated Platform for Mixture Risk Assessment Tools", SETAC North America Focused Topic Meeting on Risk Assessment of Chemical Mixtures: From Scientific Evidence to Environmental Regulation

Kim J., "External evaluation of REACH exposure assessment tools", 9th International Symposium on Modern Principles of Air Monitoring and Biomonitoring (AIRMON 2017)

Kim J., "Evaluation of REACH exposure assessment models (Inhalation)", AIHce 2017

Kim J., "How well can the mixture toxicity of engineered nanoparticles be predicted?", OpenTox Asia 2017

Jeong KH, Eggers R, Baek I-H, Kwon CA, Kim YJ., "Comparison between Zebrafish- and Human-derived Decellularized Extracellular Matrix (ECM) for Cell Culture.", Termis European Chapter Meeting, Davos, Switzerland 2017

I-H. Baek, V. Helms, YJ.Kim, "Bacteriophage functionalized polypyrrole for detection of clofibric acid using a microbalance sensor system", FEMS 2017

J. Yang, H. Jeon, S. Song, S. Kim, "Strategy for EU cosmetic regulation compliance - for cosmetic ingredient company", EU Cosmetic Regulation Seminar, London, UK

H. Jeon, J. Yang, S. Song, S. Kim, "Compliance strategy for EU REACH and cosmetic regulation", EU Cosmetic Regulation Seminar, London, UK

H. Jeon, J. Yang, S. Song, S. Kim, "Recent trend of EU chemical regulation for Korea cosmetic ingredient manufacturers", EU Cosmetic Regulation Seminar, Seoul

H. Jeon, J. Yang, S. Song, S. Kim, "Scientific Challenge of NanoSafety and Regulation", ENISH-KOREA i-NANO WORKSHOP, Aarhus, Denmark

H. Jeon, J. Yang, S. Song, S. Kim, "Update on K-REACH", 5th Annual Chemical Watch Regulatory Summit USA, Washington, D.C., USA

H. Jeon, J. Yang, O. Weiss, S. Song, S. Kim, "Nano registration under REACH: case study of MWCNT", 3rd global Nano regulation seminar, Seoul

S. Kim, "Review of REACH and about changing chemical industry in Europe", 2017 KCMA Annual meeting, Jeju

S. Kim, H. Jeon, J. Yang, S. Song, "Recent trend of nano regulation", 3rd global Nano regulation seminar, Seoul

S. Kim, H. Jeon, O. Weiss, J. Yang, S. Song, "10 years of REACH and the future policy for hazardous chemicals", 8th Korea-Japan annual meeting, Seoul

S. Kim, H. Jeon, O. Weiss, J. Yang, S. Song, "Understanding of the technological aspects for solving chemophobia", 14th National Safety Technology Forum, Seoul

S. Kim, "10 years european chemical regulation and the future policy", Invited by Institute of Health and Environment, Seoul National University

S. Kim, "10 years of REACH and the future policy for hazardous chemicals", 2017 KSLCA Conference, Jeju

S. Kim, H. Jeon, O. Weiss, J. Yang, S. Song, "Strategy for compliance with chemical regulation to place the product on the EU market", K-club workshop, Seoul

H. Jeon, "The futuer K-REACH Amendment based on EU REACH experiences", Roundtable for Committee of Environment and Labour, National Assembly, Seoul

S. Kim, "Future Chemical Risk Management; What we have learned on 10 years of REACH", 2017 International Safe Chemical Product Seminar, Seoul

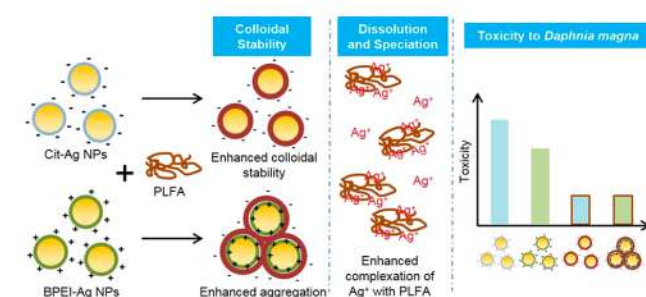






# Implications of Pony Lake Fulvic Acid for the Aggregation and Dissolution of Oppositely Charged Surface-Coated Silver Nanoparticles and Their Ecotoxicological Effects on *Daphnia magna*

## ABSTRACT



Citrate (Cit) and polyethylenimine (BPEI)-coated silver nanoparticles (AgNPs) were used to understand how the type of capping agents and surface charge affect their colloidal stability, dissolution, and ecotoxicity in the absence/presence of Pony Lake Fulvic Acid (PLFA). In the presence of PLFA, Cit-AgNPs were stabilized, while BPEI-AgNPs were aggregated. The aggregation of BPEI-AgNPs decreased with the time, and their stabilizing effect increased at high PLFA concentration. The dissolution also differed between both AgNPs and was influenced by the PLFA concentration. Generally, BPEI-AgNPs showed a lower amount of dissolved Ag than Cit-AgNPs. The dissolved Ag concentration decreased for both AgNPs at low PLFA concentration (5 mg/L). In contrast, the extent of nanoparticle dissolution increased at high PLFA concentration (30 mg/L) but only for BPEI-AgNPs. In the absence of PLFA, the ecotoxicity of Cit-AgNPs to *Daphnia magna* was higher than that of BPEI-AgNPs. However, the ecotoxicity of AgNPs in the presence of PLFA was up to 70% lower than in their absence. We demonstrated that the differences in colloidal stability, dissolution, and ecotoxicity may be attributed to the different capping agents, surface charge, and concentration of natural organic matter (NOM) as well as to the formation of dissolved Ag complexes with NOM.

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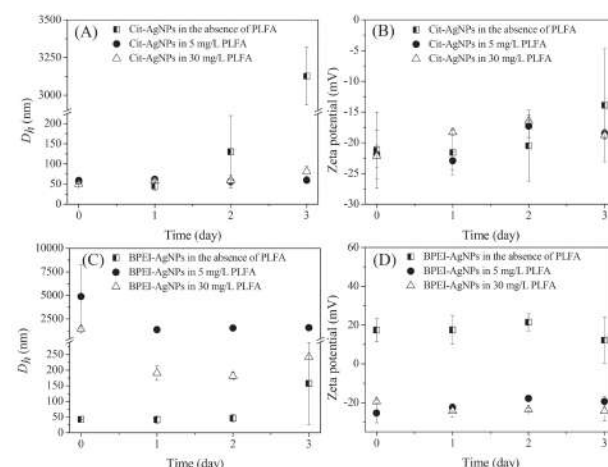


Figure 1. Mean hydrodynamic diameters ( $D_h$ , nm) (A and C) and mean zeta potentials (mV) (B and D) of 2 mg/L Cit-AgNPs and BPEI-AgNPs incubated in 10 mM  $\text{NaNO}_3$  solution in the absence and presence of 5 and 30 mg/L PLFA for 3 days. The error bars represent standard deviation of 3 replicates.

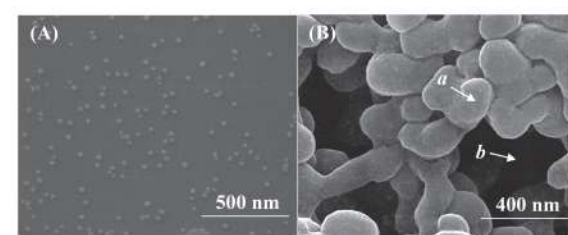


Figure 2. SEM images of 10 mg/L BPEI-AgNPs in Milli-Q water (A) and 1 mg/L BPEI-AgNPs in the presence of 15 mg/L PLFA (B). Energy Dispersive X-ray (EDX) analysis was carried at the positions of a and b in Figure (B) for the BPEI-AgNPs sample incubated in the presence of PLFA. The elemental compositions considered in this study are listed in Table 1.

	a		b	
	weight %	atomic %	weight %	atomic %
C	47.2	75.5	12.3	25.4
Ag	8.4	1.5		
S	1.6	0.9		
Si	30.5	20.9	82.7	73.2
Au	12.3	1.2	5.0	1.4

Table 1. Elemental Compositions Detected in the Sample of BPEI-AgNPs Incubated with 15 mg/L PLFA, Corresponding to Figure 2 (B)

# A Decellularized Matrix Produced by Mesenchymal Stem Cells Modulates Growth and Metabolic Activity of Hepatic Cell Cluster

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## ABSTRACT

Miniature organ-like three-dimensional cell clusters often called organoids have emerged as a useful tool for both fundamental and applied bioscience studies. However, there is still a great need to improve the quality of organoids to a level where they exhibit similar biological functionality to an organ. To this end, we hypothesized that a decellularized matrix derived from mesenchymal stem cell (MSC) could regulate the phenotypic and metabolic activity of organoids. This hypothesis was examined by culturing cells of interest in the decellularized matrix of MSCs cultured on a 2D substrate at confluency or in the form of spheroids. The decellularized matrix prepared with MSC spheroids showed a 3D porous structure with a higher content of extracellular matrix molecules than the decellularized matrix derived from MSCs cultured on a 2D substrate. HepG2 hepatocarcinoma cells, which retain the metabolic activity of hepatocytes, were cultured in these decellularized matrices. Interestingly, the decellularized matrix from the MSC spheroids served to develop the hepatic cell clusters with higher levels of E-cadherin-mediated cell-cell adhesion and detoxification activity than the decellularized matrix from the MSCs cultured on a 2D substrate. Overall, the results of this study are useful in improving biological functionality of a wide array of organoids.

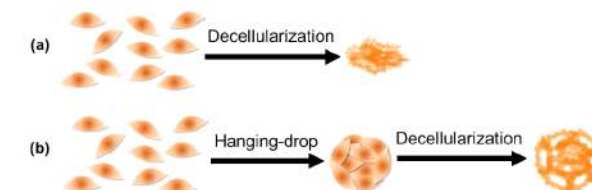


Figure 1. Schematic description of the processes to prepare decellularized matrices of mesenchymal stem cells (MSCs). (a) After culture on a cell culture flask at confluency over 3 days, MSCs were detached and incubated in the water-surfactant mixture for decellularization. (b) MSCs spheroids assembled via the Hanging drop method were incubated in the watersurfactant mixture for decellularization.

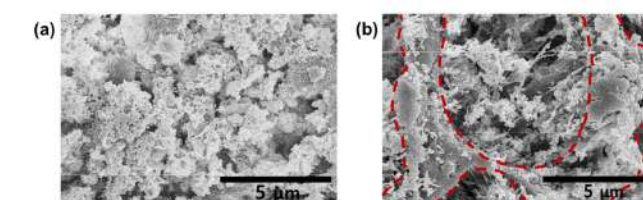


Figure 2. Scanning electron microscopy images of decellularized matrices. (a) Decellularized matrix formed by MSCs cultured on the 2D substrate (b) Decellularized matrix of MSC spheroids. In (b), red dotted line represents the boundary of a pore and white arrows represent the fibrous matrix.

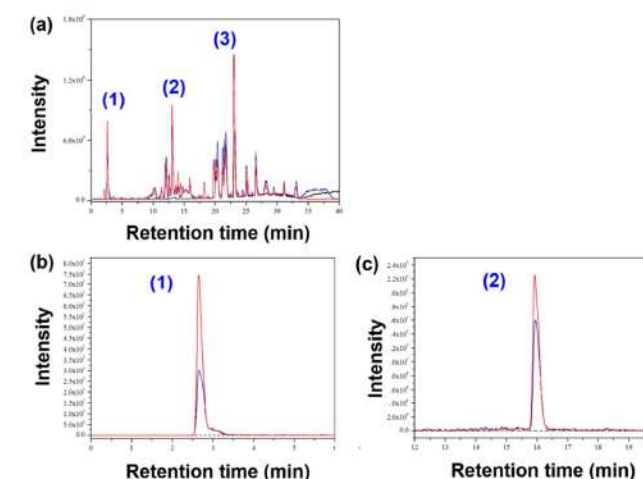


Figure 3. Chromatograms for samples run with LC-MS full scan mode; (a) Base peak chromatograms (BPC) in 40 min of running. (b) Extracted ion chromatograms (EIC) from the major peak (1). (c) Extracted ion chromatograms (EIC) from the major peak (2). For all chromatograms, black, blue and red lines indicated medium blank, the decellularized matrix of single MSCs and the decellularized matrix of MSC spheroids, respectively. Ranges beyond retention time selected (3), retention time between 20 and 40 minutes, was neglected for EIC due to existence of same peaks from medium blank.





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# BIOSENSOR AND MATERIALS

## Objectives

The group studies multidisciplinary researches based on MEMS, Microfluidics, Chemistry, Biology, Magnetics and Material science, etc.

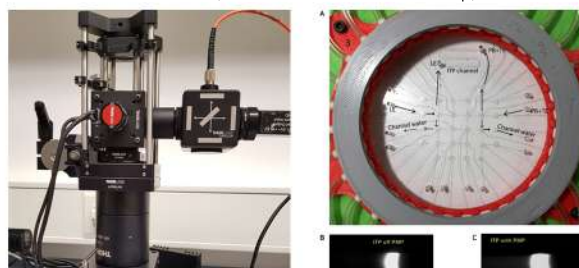
The group consists of 3 laboratories such as Biosensor and Microfluidics Lab., Magnetic Materials Lab., and Energy Transformation and Storage Laboratory developing core technologies of various sensor including microfluidic platforms, advanced electrochemical systems as well as magnetic micro- and nano materials for applications to the alternative animal tests and the smart sensor/energy systems.

## R&D Areas

### Biosensor and Microfluidics

- Ultra high efficient capillary electrophoresis
- Enzyme-based bio sensor
- Organ on a chip and Biomimetic microfluidics
- High sensitive microfluidic sensor platform using FFITP pre-concentration
- Electro-Chemical Luminescent sensor system

Bile canaliculi formation of HepG2 cells under different culturing conditions (3D culture in microfluidic chip)



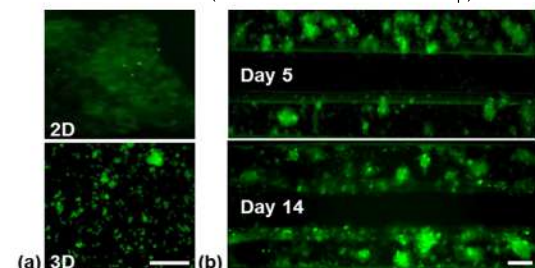
### Magnetic Materials

- Microfabricated magnetic elements and self-assembly
  - └ Nanofabricated magnetic particles as alternative to colloidal particles
  - └ Novel functional materials based on magnetic interaction
- Magnetic bacteria and bacteriophages
  - └ Magnetically control of micro-organisms for drug delivery, environmental sensing and elimination of toxic compounds
  - └ Biomineralisation on viruses and inside bacteria and novel functional materials

### Electrochemical Energy Transformation & Storage

- High temperature PEM fuel cell
- Redox flow batteries
  - └ All vanadium redox flow battery
  - └ Hydrophilic Ionic Liquids as supporting salts
  - └ Organic compounds as redox active species

Bile canaliculi formation of HepG2 cells under different culturing conditions (3D culture in microfluidic chip)



# ACHIEVEMENTS 2017



## Journals

Yuliya E. Silina, Jennifer R. Tillotson, Andreas Manz, "Storage and controlled release of fragrances maintaining a constant ratio of volatile compounds", RSC Analytical Methods, 9, 6073-6082

Seung Jae Lee, Eric R Castro, Rosanne M Guijt, Mark D Tarn, Andreas Manz, "Van de Graaff generator for capillary electrophoresis", J. Chromatogr. A 1517, 195-202

Wenming Wu, Andreas Manz, "Biocompatibility assay of cellular behavior inside leaf-inspired biomimetic microdevice at single cell level", RSC Advances, 7, 32710-32720

Xiangping Li, Wenming Wu, Andreas Manz, "Thermal gradient for fluorometric optimization of droplet PCR in virtual reaction chambers", Microchimica Acta, 184, 3433-3439

Neha Agarwal, Hyobong Ryu, Melanie Mangang, Wilhelm Pfleging, Jungtae Kim, "Direct writing of a conducting polymer pattern in aqueous solution by using an ultrashort laser pulse", RSC Advances, 7, 38565-38569

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M Dirnberger, K Mehlhorn and T Mehlhorn, "Introducing the slime mold graph repository", Journal of Physics D: Applied Physics, 50, 264001

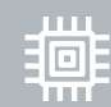
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## Book

Ruiyong Chen, Sangwon Kim, Zhenjun Chang, "Redox: Principles and Advance Applications - Redox flow batteries: fundamentals and applications", InTech, 2017

## PhD Thesis

Seung Jae Lee, "High Performance capillary electrophoresis using Van de Graaff generator", University of Saarland

Ana Vanessa Almeida, "Virtual reaction chambers as a tool for DNA sequencing", University of Saarland

Mi Jang, "Microfluidic-based 3D hepatic cell cultivation as a new in vitro model for inflammation study", University of Saarland

## Proceedings

Miguel Solsona, Anna-Eva Nieuwelink, Vasileios Papadimitriou, Jan Eijkel, Florian Meijer, Leon Abelman, Wouter Olthuis, Bert Weckhuysen, Albert van den Berg, "Concentration Polarization to Measure Nano-pore Accessibility", MicroTas 2017, Oct. Savannah

Miguel Solsona, Anna-Eva Nieuwelink, Mathieu Odijk, Florian Meijer, Leon Abelman, Wouter Olthuis, Bert Weckhuysen, Albert van den Berg, "Magnetophoretic Sorting Of Fluid Catalytic Cracking Particles", MicroTas 2017, Oct. Savannah

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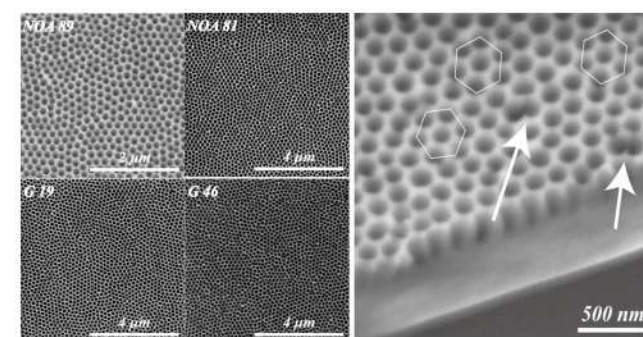
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Abelmann, L; Blaudszun, A; Ledwig, M; Pan, Li; Park, BC Kim, YK, "Magnetic particle spectrometry of Fe<sub>3</sub>O<sub>4</sub> nanoclustered particles", IEEE Int. Magnetism Conference (INTERMAG), 2017 April, Dublin

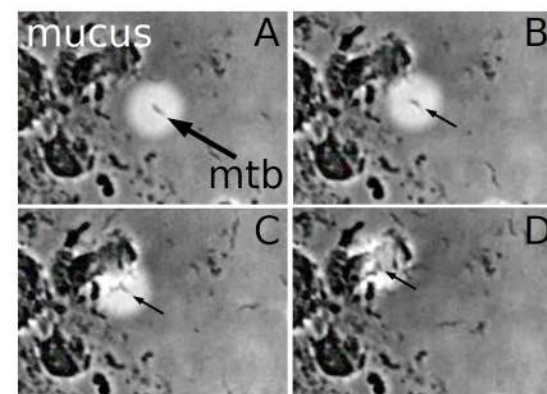
Löthman, P; Janson, T; Klein, Y; Blaudszun, A; Ledwig, M ; Abelmann, L, "High frequency magnetic response of microfabricated magnetic discs", IEEE Int. Magnetism Conference (INTERMAG), 2017 April, Dublin

Pichel, M, Hageman, T, Korkmaz, N, Löthman, P, Murgia E, Lehr, CM, Abelmann, L., " Microfluidic platform for observing penetration of human mucus by magnetotactic", IEEE Int. Magnetism Conference (INTERMAG), 2017 April, Dublin

Hageman, T, Löthman, P, Dirnberger, M, Elwenspoek, M, Manz, A, Abelmann, L, "Turbulence-driven macroscopic magnetic self-assembly with adjustable level of agitation", IEEE Int. Magnetism Conference (INTERMAG), 2017 April, Dublin



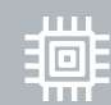
Biomimetic nano well array



Video snapshots of a magneto-tactic bacterium (mtb) approaching and entering human mucus.







## Van de Graaff generator for capillary electrophoresis

### ABSTRACT

A new approach for high voltage capillary electrophoresis (CE) is proposed, which replaces the standard high voltage power supply with a Van de Graaff generator, a low current power source. Because the Van de Graaff generator is a current-limited source (10  $\mu$ A), potentials exceeding 100 kV can be generated for CE when the electrical resistance of the capillary is maximized. This was achieved by decreasing the capillary diameter and reducing the buffer ionic strength. Using 2 mM borate buffer and a 5  $\mu$ m i.d. capillary, fluorescently labeled amino acids were separated with efficiencies up to 3.5 million plates; a 5.7 fold improvement in separation efficiency compared to a normal power supply (NPS) typically used in CE. This separation efficiency was realized using a simple set-up without significant Joule heating, making the Van de Graaff generator a promising alternative for applying the high potentials required for enhancing resolution in the separation and analysis of highly complex samples, for example mixtures of glycans.

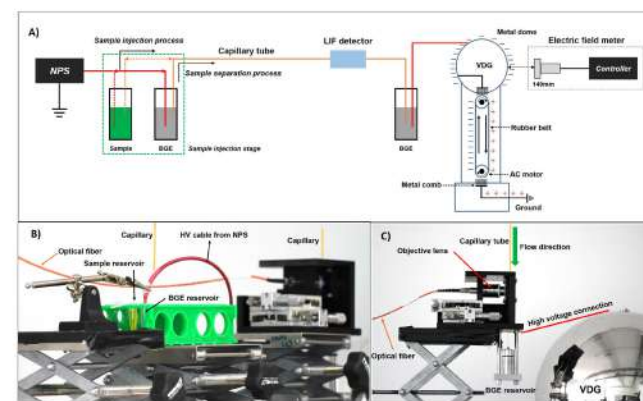


Fig. 1. Experimental setup of a Van de Graaff (VDG) generator for capillary electrophoresis. (A) Schematic diagram of the platform, illustrating a capillary tube inserted into a sample or background electrolyte (BGE) reservoir connected to a "normal" DC power supply (NPS) at the capillary inlet, and to a BGE reservoir connected to the VDG at the capillary outlet. The operating principle of the VDG is illustrated on the right, in which a moving rubber belt generates a negative charge that is collected at the dome. Sample injection was achieved electrokinetically using the NPS. In order to measure the electric field strength generated by the VDG, an electric field meter was placed 140 mm away from the dome. (B) For sample injection, the capillary and electrode connected to the NPS for electrokinetic sample injection were temporarily moved to the sample vial and 5 kV was applied for 3 s. After this, the grounded electrode and capillary were moved back to the buffer reservoir. (C) The capillary was aligned with a microscope objective connected to an optical fiber for laser-induced fluorescence (LIF) detection near to the outlet of the capillary. The outlet of the capillary was inserted into a stainless steel buffer reservoir that was electrically connected to the VDG via a platinum wire.

Seung Jae Lee<sup>a</sup>, Eric R. Castro<sup>a</sup>, Rosanne M. Guijt<sup>a,b,1</sup>, Mark D. Tarn<sup>a,2</sup>, Andreas Manz<sup>a,\*</sup>

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<sup>b</sup> School of Medicine and ACROSS, University of Tasmania, Private Bag 26, Hobart, TAS 7001, Australia

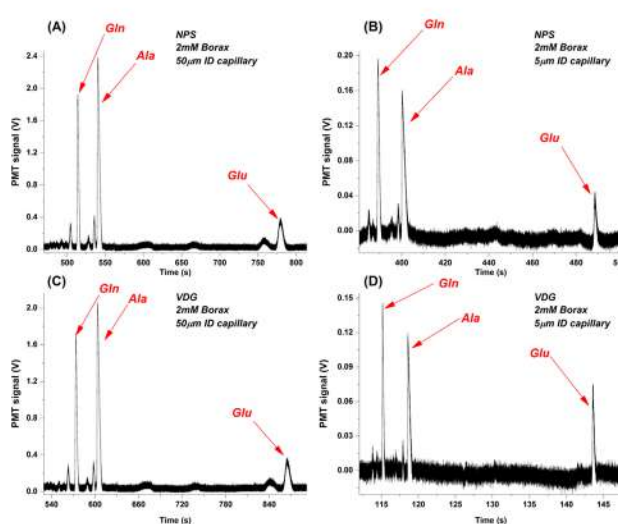


Figure 2. The effect of capillary diameter on the separation and migration times of three amino acids (AAs) using the VDG CE platform (2 mM borax background electrolyte) and the normal 30 kV power supply (NPS) for comparison. The plots show the separation of AAs achieved with (A) a 50  $\mu$ m i.d. capillary using the NPS, (B) a 5  $\mu$ m i.d. capillary using the NPS, (C) a 50  $\mu$ m i.d. capillary with the VDG, and (D) a 5  $\mu$ m i.d. capillary with the VDG.

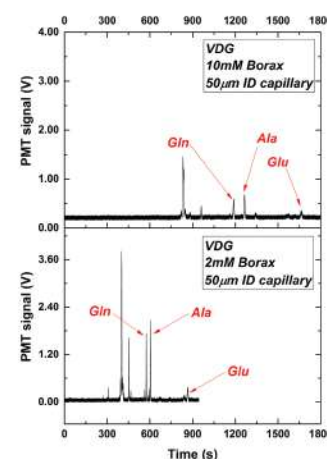


Fig. 3. The effect of background electrolyte (borax buffer) concentration on separation and migration times of amino acids using the VDG CE platform (50  $\mu$ m i.d. capillary). Electropherograms show separations in (A) 10 mM borax buffer, and (B) 2 mM borax buffer.

## Redox Flow Batteries for Energy Storage: A Technology Review

### ABSTRACT

The utilization of intermittent renewable energy sources needs low-cost, reliable energy storage systems in the future. Among various electrochemical energy storage systems, redox flow batteries (RFBs) are promising with merits of independent energy storage and power generation capability, localization flexibility, high efficiency, low scaling-up cost, and excellent long charge/discharge cycle life. RFBs typically use metal ions as reacting species. The most exploited types are all-vanadium RFBs (VRFBs). Here, we discuss the core components for the VRFBs, including the development and application of different types of membranes, electrode materials, and stack system. In addition, we introduce the recent progress in the discovery of novel electrolytes, such as redox-active organic compounds, polymers, and organic/inorganic suspensions. Versatile structures, tunable properties, and abundant resources of organic-based electrolytes make them suitable for cost-effective stationary applications. With the active species in solid form, suspension electrolytes are expected to provide enhanced volumetric energy densities.

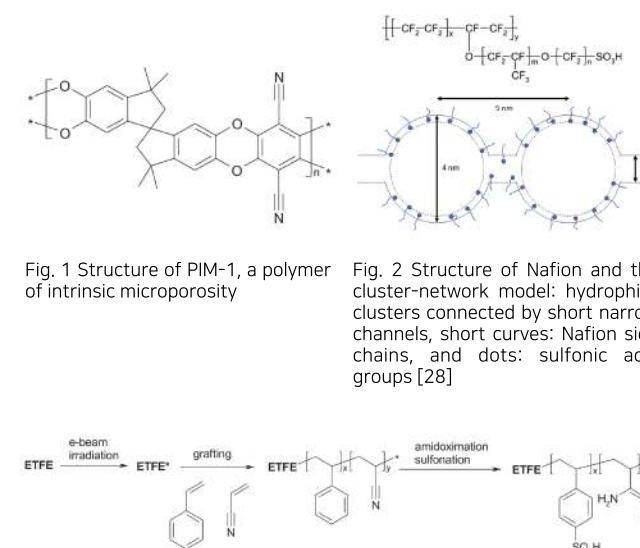


Fig. 1 Structure of PIM-1, a polymer of intrinsic microporosity

Fig. 2 Structure of Nafion and the cluster-network model: hydrophilic clusters connected by short narrow channels, short curves: Nafion side chains, and dots: sulfonic acid groups [28]

Fig. 3 Membrane preparation in a pre-irradiation grafting process. Bifunctionalized ETFE-graftpoly(styrene-co-acrylonitrile) membranes were obtained via activation by electron-beam irradiation, grafting of styrene and acrylonitrile, amidoximation, and sulfonation. Under the acidic conditions, the amidoxime groups are probably in protonated, positively charged form.

Ruijie Ye<sup>a,b</sup>, Dirk Henkensmeier<sup>c,d,e</sup>, Sang Jun Yoon<sup>a,b,f</sup>, Zhifen Huang<sup>a,b</sup>, Dong Kyu Kim<sup>a,b,g</sup>, Zhenjun Chang<sup>a,b,h</sup>, Sangwon Kim<sup>a,b</sup>, Ruiyong Chen<sup>a,b</sup>

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<sup>e</sup> Green School, Korea University, Seoul 02841, South Korea.

<sup>f</sup> Center for Membranes, Advanced Material Division, Korea Research Institute of Chemical Technology, Daejeon 34114, South Korea.

<sup>g</sup> Department of Medical and Aerospace Engineering, Seoul National University, Seoul 08826, South Korea.

<sup>h</sup> College of Materials Science and Engineering, Jiangsu University of Science and Technology, Zhenjiang 212003, China.

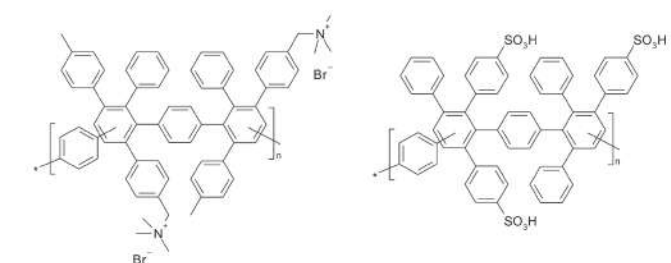


Fig. 4 A Diels-Alder poly(phenylene) with quaternary ammonium groups (left) and sulfonic acid groups (right)

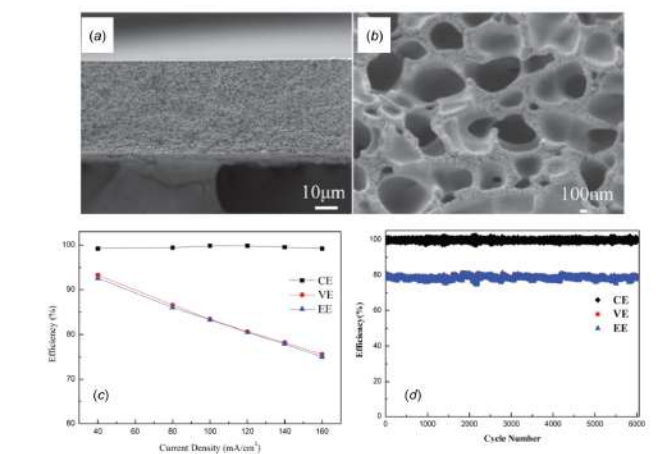


Fig. 5 (a) and (b) Cross-sectional SEM images of a CMPSF membrane immersed for 3 days in an imidazole solution, (c) dependence of the efficiencies on the current densities, and (d) cycling test at 120 mA cm<sup>-2</sup>. (Reproduced with permission from Zhao et al. [14]. Copyright 2016 by Wiley.)





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Head of Smart Convergence Group  
hwang@kist-europe.de



# SMART CONVERGENCE

## Objectives

Smart convergence group contributes to novel smart applications and its enabling technologies. Currently, we develop the key solutions for smart factory with Korean and German partners. Next step will be the extended application of the key solutions to various Internet of Things solutions and services such as smart healthcare and smart city.

## R&D Areas

### Future Applications and Services

- Novel smart service scenarios
- Development of mobile and web applications

### Data Analysis

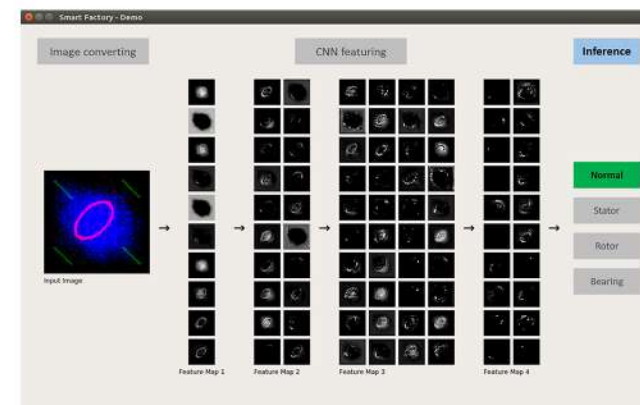
- Research on data collection, processing and data mining
- Development of machine learning algorithms that enable smart services

### Software development and global testbed

- Development of control and monitoring system
- Global collaboration testbed in Industry 4.0



Cyber-Physical Production System Demonstrator



CNN-based Fault detection of 3-Phase Induction Motor

# ACHIEVEMENTS 2017



## Proceedings

Lee, Y.; Jo, J.; Hwang, J., "Application of Deep Neural Network and Generative Adversarial Network to Industrial Maintenance: A Case Study of Induction Motor Fault Detection", In proceedings of IEEE International Conference on Big Data 2017, Boston, (2017)

Cha, S.; , Lee, S; Jo, J; Lee, Y; Hwang, J; "Deep Neural Network Based Fault Detection for Three-Phase Induction Motor", In proceedings of Asia Pacific Conference of the Prognostics and Health Management Society (PHM Asia Pacific) 2017, Jeju, (2017)

## Oral Presentation

Hüster, M., "IBM Industrie 4.0 SPSS Analytics: Getting Started Exercise", In 2nd BMBF Big Data All Hands Meeting and 2nd Smart Data Innovation Conference, Karlsruhe (2017)

Hwang, J., "Research & Collaboration Activities of KIST Europe – relevant to Smart Factory", in Hannover Messe 2017, Hannover (2017)

Hwang, J., "4th industrial revolution, AI and KIST Europe", invited talk in TTA, Seongnam-si (2017)

Hwang, J., "4th industrial revolution, AI and Industrial Impact", invited talk in KBA annual meeting, Paris (2017)

Kim, H., "The 4th Industrial Revolution in ICT-manufacturing Convergence", invited talk in KAIST, Daejeon (2017)

Kim, H.; Lee, Y., "The 4th Industrial Revolution in Germany and Korea and R&D achievement of smart factory in KIST Europe", in seminar with Korea Industry 4.0 Innovation (2017)

## Collaboration Activities

Member of SmartFactoryKL AG2

- Development of cloud predictive maintenance by using data analytics

ETRI-KIST Europe Joint Research Lab

- Development of interoperation method between ETRI's CPPS system and German RAMI 4.0 model

Partner of Software Cluster

- Official partner institution of software cluster

Kyoung Hee University-KIST Europe Joint Research Lab

- Personal exchange & training program, Joint Research Planning
- MoU agreement with GIST
- Collaboration in the field of artificial intelligence

## Current Projects

ATC Global Convergence Program

- Development of IoT monitoring system supporting an auto-packaging machine of ACE machinery

Connected Smart Factory Program

- Development of a smart manufacturing system test-bed based on CPPS middleware and trial of its interoperability with smart factory test-bed of EU/Germany

Strategic Project of NST

- Strategic planning of NST convergence research program

Basic Fund Research

- Development of Remote Maintenance as Smart Customer Service in Machinery Industry





## Application of deep neural network and generative adversarial network to industrial maintenance: A case study of induction motor fault

Lee, Y. O., Jo, J., &amp; Hwang, J.

### ABSTRACT

As data visibility in factories has increased with the deployment of sensors, data-driven maintenance has become popular in industries.

Machine learning has been a promising tool for fault detection, but the problem is that the amount of fault data is much less than that of normal data which causes a data imbalance.

In this study, we designed a deep neural network for fault detection and diagnosis, and compared the oversampling by a generative adversarial network to standard oversampling techniques.

Simulation results indicate that oversampling by the generative adversarial network performs well under the given condition and the deep neural network designed is capable of classifying the faults of an induction motor with high accuracy.

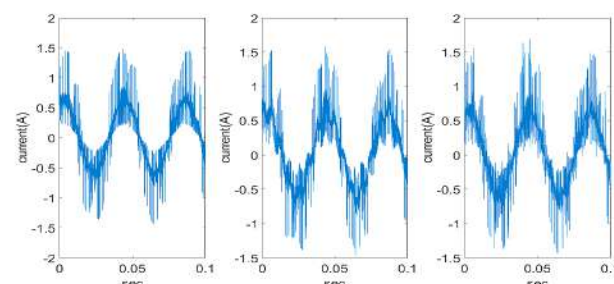


Fig. 2 Normal, rotor fault and bearing fault signals, respectively

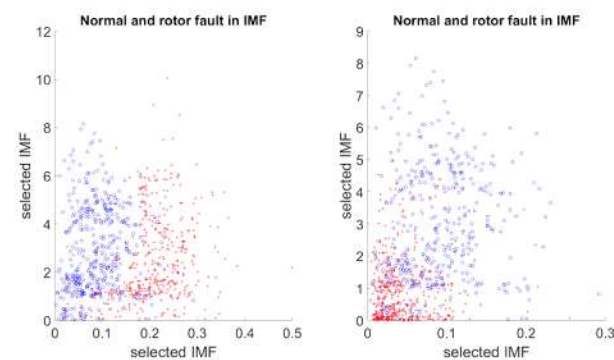


Fig. 3 Comparison between a normal and fault condition in EMD



Fig. 1 Test bench (model: EMOD FKIE2100LA, P<sub>mech</sub>: 3 kW, n<sub>nom</sub>: 1440 /min, V<sub>nom</sub>: 400V, I<sub>nom</sub>: 6.4A, cosφ: 0.78)

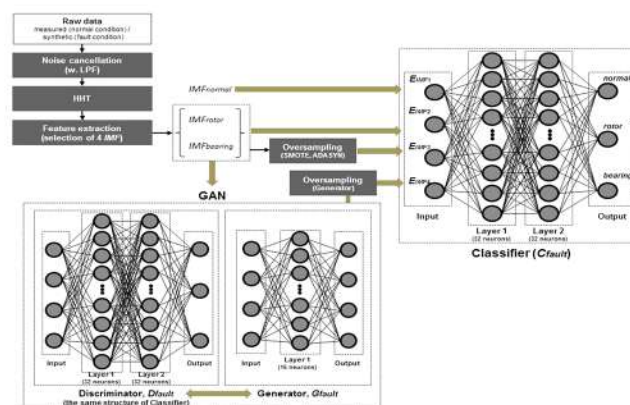


Fig. 4 Concept of data preparation, oversampling and fault detection

### INTRODUCTION

Industry 4.0 has transformed the manufacturing environment.

As data visibility in factories has increased with the deployment of sensors, decision making such as planning, control and maintenance has shifted to data-driven strategies.

Among these strategies, maintenance efficiency is expected to improve with optimized maintenance activities [1].

Data-driven maintenance is an advanced methodology for monitoring the condition of machines and equipment in order to analyze and determine the best time for maintenance activities.

Data-driven maintenance is more economically efficient than traditional maintenance methods like time-based maintenance.

It promotes higher system reliability by allowing for the components of a machine to be used for the extended life span and by repairing and replacing components before actual breakdowns occur and cause other more expensive problems [2].

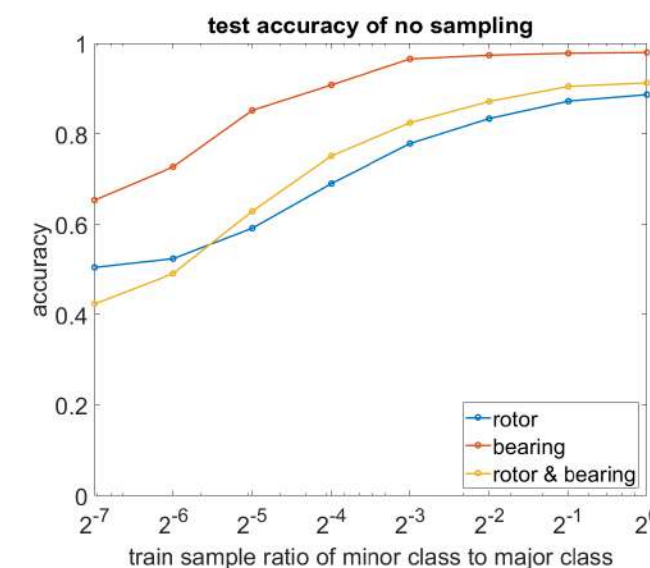


Fig. 5 Experimental results of no sampling

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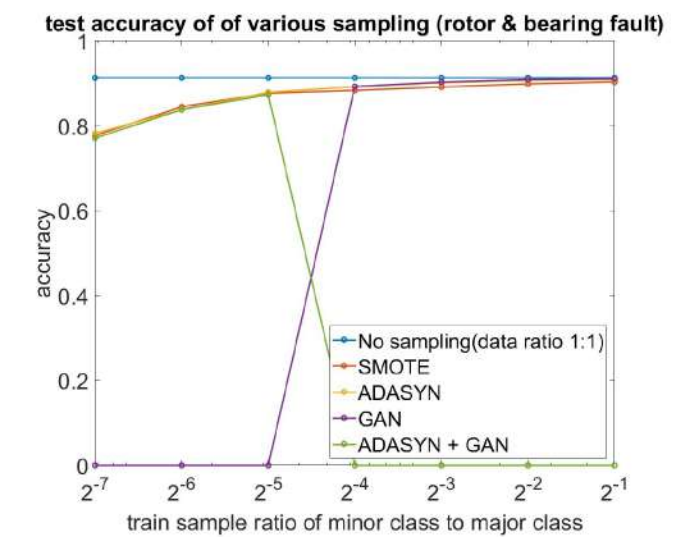
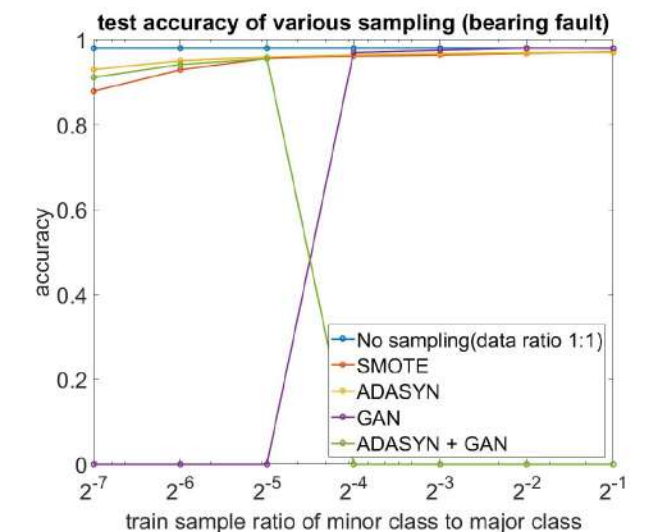
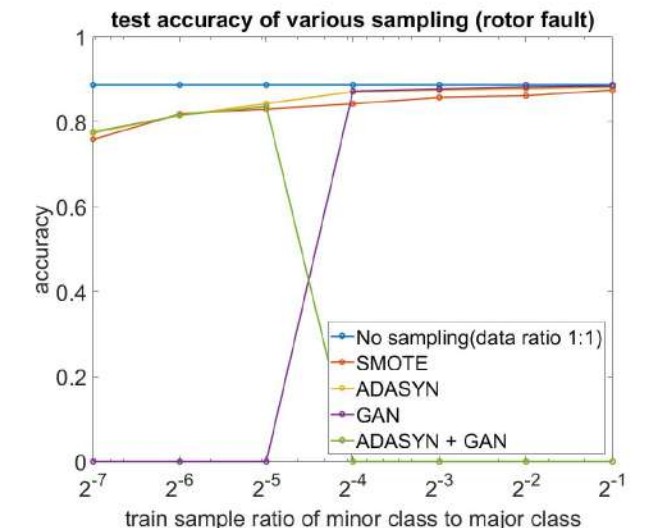


Fig. 6 Experimental results of sampling

# G

Global Cooperation for the FUTURE

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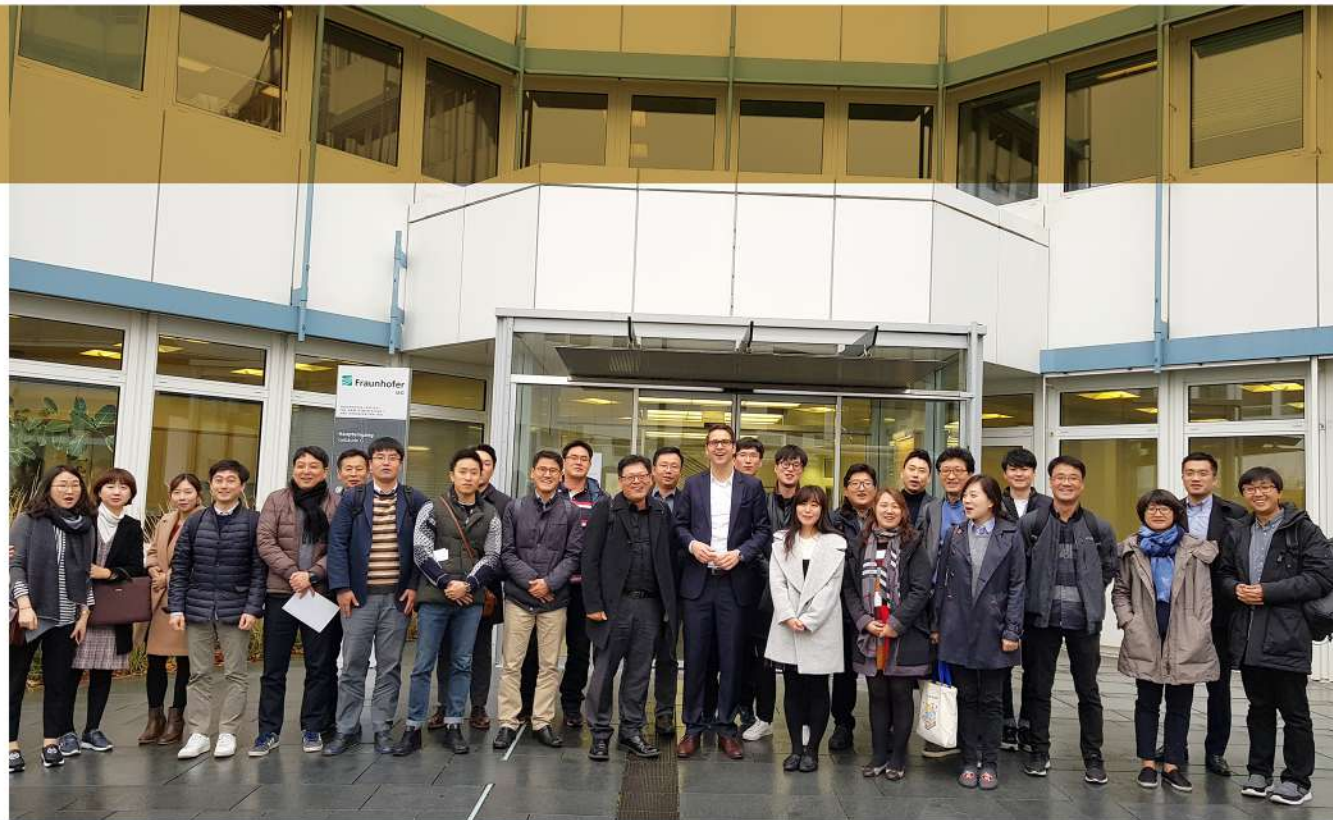
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Korea Institute of  
Science and Technology



# KOREA-EU STRATEGIC NETWORKING



## Hosting of 2017 Korea-EU Innovation Academy 2017

### Date/Place

November 5<sup>th</sup>-15<sup>th</sup>, 2017 / Germany and Switzerland

**Host Institutes** : KIRD (Korea Institute of Resources Development in Science and Technology) KIST Europe

**Topic** : 4<sup>th</sup> Industrial Revolution Policy and Paradigm Shift in Science and Technology Sector

- 4<sup>th</sup> Industrial Revolution and European Case Study Korean-Type 4<sup>th</sup> Industrial Revolution Roadmap and Strategy
- Cultivation of Joint Research Capacity

**Participants** : 30 Scientific & Technological Personnel engaging in policy and Strategic field and 4<sup>th</sup> industrial revolution-related tasks at government-run research institutes

**Visited Institutes** : (In Germany) KIST Europe, CISPA, DFKI, SmartfactoryKL, (In Germany) Cross Cluster Industries 4.0, Fraunhofer IAO, ELABO (In Switzerland) Switzerland Innovation Park



## Participation in the EKC 2017

**Date/Place** : July 26<sup>th</sup>-29<sup>th</sup>, 2017 / Stockholm, Sweden

**Main Organiser** : KSSEA (Korean-Scandinavian Scientists and Engineers Association)

Main Organiser	Co-organiser
 KSSEA	        

### Topic

- Exchange useful Knowledge and bright ideas for the promotion of Science and Technology in service of the human being and the society
- Development of friendship among Korean scientists in Europe

### Details

Participation in Oral presentation and Poster session

### Participants

Approx. 650 scientists (KIST Europe Scientists : 17)



## Participation in the 3<sup>rd</sup> BiKiE Symposium at University of London

**Date/Place** : September 16<sup>th</sup>-17<sup>th</sup>, 2017 / London, UK

**Topic** (※BiKiE : Bio Korea in Europe)

- Participation in Presentation Session
- Development of internal networking between Korean scientists in the field of biological science in Europe

**Details** : Presentation on Theme Bio-materials, Toxicity and Prediction (Dr. Jong woon Kim, Young Jun Kim, Prof. Dr. Leon Abellmann)

**Participants** : Approx. 60 scientists (KIST Europe Scientists : 8)



## ACTIVITIES WITH EUROPEAN ORGANIZATIONS

### Registration as a partner in the German Software-Cluster

#### Overview of the Software-Cluster

(funded by the German Federal Ministry of Education & Research)

- Main Function : Joint Research, Networking, Education and Training in the area of software development and 4<sup>th</sup> Industrial revolution
- Cluster Region : Southwest of Germany around the cities of Darmstadt,

**Registration Date** : March 16<sup>th</sup>, 2017 (Verification Period : Jan-Mar 2017)

**Cooperation organizations** : Approx. 11,000 such as Fraunhofer, DFKI, SAP, University of Saarland etc.



### KIST Europe-University of Saarland "TSE Center" Opening Ceremony

**Date/Place** : April 24<sup>th</sup>, 2017 / Saarbrücken

#### Name of Center

- Transfercentre Sustainable Electrochemistry

#### \* Brief History

- 1997. 1 / 2006. 4 : Agreement on Scientific and Technological Cooperation between KIST Europe and University of Saarland
- 2015. 3. : Joint Electrochemistry Lab Opening in KIST Europe
- 2016. 10. : Agreement on Establishment TSE

#### Participants

- KIST Europe : Dr. Kuiwon Choi, Dr. Sangwon Kim
- University of Saarland :  
Prof. Dr. Manfred Schmitt (President)  
Prof. Rolf Pelster (Faculty : Physics)  
Prof. Dr. Rolf Hempelmann (Faculty : Chemistry)

### Hosting of the 1<sup>st</sup> Korea-Germany Environmental Workshop

**Date/Place** : October 12<sup>th</sup>-13<sup>th</sup> 2017 / Korean Embassy in Bonn, Germany

#### Co-Host Organizations

Korean Embassy in Bonn, VeKNI, KEITI



### Ursapharm On-site Lab Opening Ceremony

**Date/Place** : April 28<sup>th</sup>, 2017 / KIST Europe

#### Full Name of Lab

Innovative Product Development Laboratory

#### \* Ursapharm Company

- Consistent Transfer of innovative pharmaceutical conceptions into successful medicine and medicinal products
- International medium-sized company in the field of ophthalmology

#### Purpose

- Joint research & Development of new Product
- Planning of commercialization



**Theme** : Efficient ways to improve air quality

**Participants** : 40 Korean-German Experts in the field of Environmental issues

## ACTIVITIES WITH KOREAN ORGANIZATIONS



### KIST Europe-Kyung Hee University Joint Research Lab Opening Ceremony

**Date/Place** : July 24<sup>th</sup>, 2017 / KIST Europe

#### Name of Laboratory

KHU-KIST Europe Joint Research Lab.

#### Participants

- KIST Europe : Dr. Kuiwon Choi, Heung-Nam Kim, Jongwoon Hwang, Jeongho Seo
- KHU Computer Engineering Faculty :Dr. Jinsung Cho, Dr. Young Koo Lee, Dr. Sungwon Lee



### KIST Europe-KIT Joint Research Center Opening Ceremony

**Date/Place** : September 5<sup>th</sup>, 2017 / KIST Europe

**Name of Center** : Joint Research Center for Alternative & Predictive Toxicology (JRC-APT)

#### Participants

- KIST Europe : Dr. Kuiwon Choi, Heung-Nam Kim, Jungtae Kim, Sanghun Kim, Youngjun Kim, Hyun Pyo Jeong, Seungyun Baik
- KIST : Dr. Mungoo Jung (Director), Dr. Seokju Yoon, Dr. Junwoo Park

### Participation in the 18<sup>th</sup> Innovative Technology Show

**Date/Place** : September 14<sup>th</sup>-16<sup>th</sup>, 2017 / Seoul, Korea

#### Activities

- Running KIST Europe Booth and consulting Small and medium sized enterprises to extend business areas into Europe
- Attending with the gwSaar (Saarland Economic Promotion Corporation)



### Participation in 2017 VeKNI Annual Committee

**Date/Place** : October 22<sup>nd</sup>-23<sup>rd</sup>, 2017 / Essen, Germany

#### Topic

- Seminar Session and Networking, Presentation on KIST Europe
- Korean Governments R&D Investment Direction
- R&D Project Planning on Industrial Technology



REPRESENTATIVE EVENTS

Industry Support for Environmental Regulation

EU REACH, Korea-REACH (K-REACH)

- \* **REACH** : Registration, Evaluation, Authorization and Restriction of Chemicals
- \* **BPR** : Biocidal Products Regulation
- Introduction of KIST Europe's activity for industry, trend of relating regulations
- Consulting for Lead Registration, Joint Research, IP, Technology Registration etc.



Achievements 2017



K-REACH and K-BPR Infoday

- **Date/Place** : April 27<sup>th</sup>, 2017 / Cologne, Germany
- **Purpose** : Advise European Companies of the revised K-REACH and K-BRP regulation-the new chemical legislation



In-Cosmetic Workshop

- **Date/Place** : April 5<sup>th</sup>, 2017 / London, UK
- **Purpose** : Compliance to the current EU Environmental regulation for cosmetic ingredients companies and the EU Cosmetic Regulations for Korean cosmetic companies



K-REACH and K-BPR Infoday

- **Date/Place** : June 21<sup>th</sup>, 2017 / Seoul, Korea
- **Purpose** : Explanation and consulting EU-REACH and EU Cosmetic Regulations for the Korean cosmetic ingredients manufacturer and related companied

Workshop for the Planning of KIST Europe's long-term vision

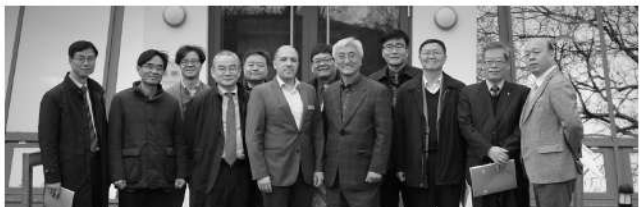
**Date/Place** : February 22<sup>th</sup>-24<sup>th</sup>, 2017 / KIST Europe  
**Purpose**  
Discussion about Management and Research Sector

Schedule

Date	Time	Contents
22-Feb	10:30-12:00	Orientation
	13:00-14:00	Meeting with resident organizations in KIST Europe
	15:00-17:00	Visit the DFKI Smartfactory Consortium
23-Feb	10:00-12:00	Discussion about Management Sector
	14:00-17:00	Discussion about Research Sector
24-Feb	10:00-12:00	General Discussion

Panels

- Dr. Heung-Nam Kim (Former ETRI President),
- Prof. Sunyang Jeong (Kunkuk Univ.),
- Mr. Seok Bong Lee (CEO of HelloDD),
- Dr. Jung Won Lee (STEPI Vice President),
- Dr. Daehyun Oh (OECD Science Attaché),
- Mr. Jeong Joong Kim (Vice CEO of WIPS),
- Dr. Yoo Hyung Won (KIST).



GUESTS AT KIST EUROPE

Overview

**Total Number of Guests** : 274 Persons

- Most of guests had more obvious objective, such as Joint Research, Project Planning and MoU (266/274)
- Especially, in 2017, many guests had great interest in 4th Industrial Revolution Theme (133/274)
- 36% of guests were from GSRI (Government-Supported Research Institute)

Table. 1. Classification according to guest organization

Type of Organization	Number of Visitor
Public Office	54
Public Institution	100
Korean University	47
Foreign University	5
Company	62
NGO	4
Press	2
Sum	274

Table. 2. Classification according to visiting department

Visiting Department	Number of Visitor
Environmental Safety Group	38
Biosensor & Materials Group	32
Smart Convergence Group	133
KIST Europe	71
Sum	274



Visit of the delegation from MSIP with the 2nd Vice Minister

**Date** : April 7<sup>th</sup>-8<sup>th</sup>, 2017

**Purpose** : Check on current status of KIST Europe Business and Management Plan

Delegation

- MSIP : Mr. Jaeyoo Choi (Vice Minister), Mr. Hae gun Jo, Mr. Tae Seung Lee, Mr. Hong Kwon Yoon
- Korean Embassy in Bonn : Dr. Jin Hyung Kim (Science Attaché)
- National IT Industry Promotion Agency : Mr. Sungwoo Shin, Mr. Danwoo Jo



Visit of the delegation from MSIP with the 2nd Vice Minister

**Date** : April 27<sup>th</sup>-29<sup>th</sup>, 2017

Topic

- Report on KIST Europe long-term Vision Presentation
- Visiting of neighbor Institutions (TSE, DFKI and HIPS)
- Participation of the opening ceremony of Ursapharm on-site Lab.

**Delegation** : Dr. Sang Chun Lee (NST President), Mr. Ick Chan Lee, Ms. Ji-Sun Ahn



Visit of the President of KIST Seoul

**Date** : July 21<sup>th</sup>-23<sup>th</sup>, 2017

Topic

- Report on KIST Europe long-term Vision Presentation
- Discussion on ongoing research themes with Senior Researchers



# COOPERATION AGREEMENTS



## MoU between KIST Europe – Kyung Hee University-Industry Cooperation Foundation

**Date/Place** : February 6<sup>th</sup>, 2017 / Seoul, Korea

### Contents

- Establishment the laboratory for academic research cooperation
- Offering internship programs for human resource development
- Promotion of Joint research collaboration



## MoU between KIST Europe – Gwangju Institute of Science and Technology (GIST)

**Date/Place** : August 28<sup>th</sup>, 2017 / KIST Europe

**Cooperation Field** : Exchange of Members and Research Collaboration

**Visitors** : Dr. Seung-Hyeon Moon (President), Mr. Moon-Gu Jeon, Mr. Young Chul Kim, Ms. Soo Jeong Park



## LoI between KIST Europe – School of Organic and Mineral Chemistry (ESCOM)

**Date/Place** : February 16<sup>th</sup>, 2017 / ESCOM, France

### Contents

- Exchange and training of faculty members, staffs, students
- Exchange of academic materials and publications
- Identification of further collaborative activities

**Details** : ESCOM Student's Participation in the KIST Europe Research Project : Electrochemical Energy Transformation and Energy Storage



## Agreement between KIST Europe Environmental Safety Group – KRICT Center for Chemical Analysis

**Date** : July 10<sup>th</sup>, 2017

**Contents** : Agreement for Cooperation in the field of Analysis on the "EU REACH and K-REACH EU-REACH



## MoU between KIST Europe – OJeong Eco-Resilience Institute

**Date/Place** : September 18<sup>th</sup>, 2017 / Seoul, Korea

### Cooperation Field

- Environmental Safety and Climate Change
- Staff interactions
- Education, outreach and professional development



## MoU between KIST Europe – Hanyang University – University of Saarland

**Date/Place** : October 19<sup>th</sup>, 2017 / Saarbrücken, Germany

### Contents

- Initiating a joint degree program and conducting joint research activities
- Exchange of faculty members, researchers and staffs, graduate students
- Exchange of information and academic publications
- Holding lectures and symposia

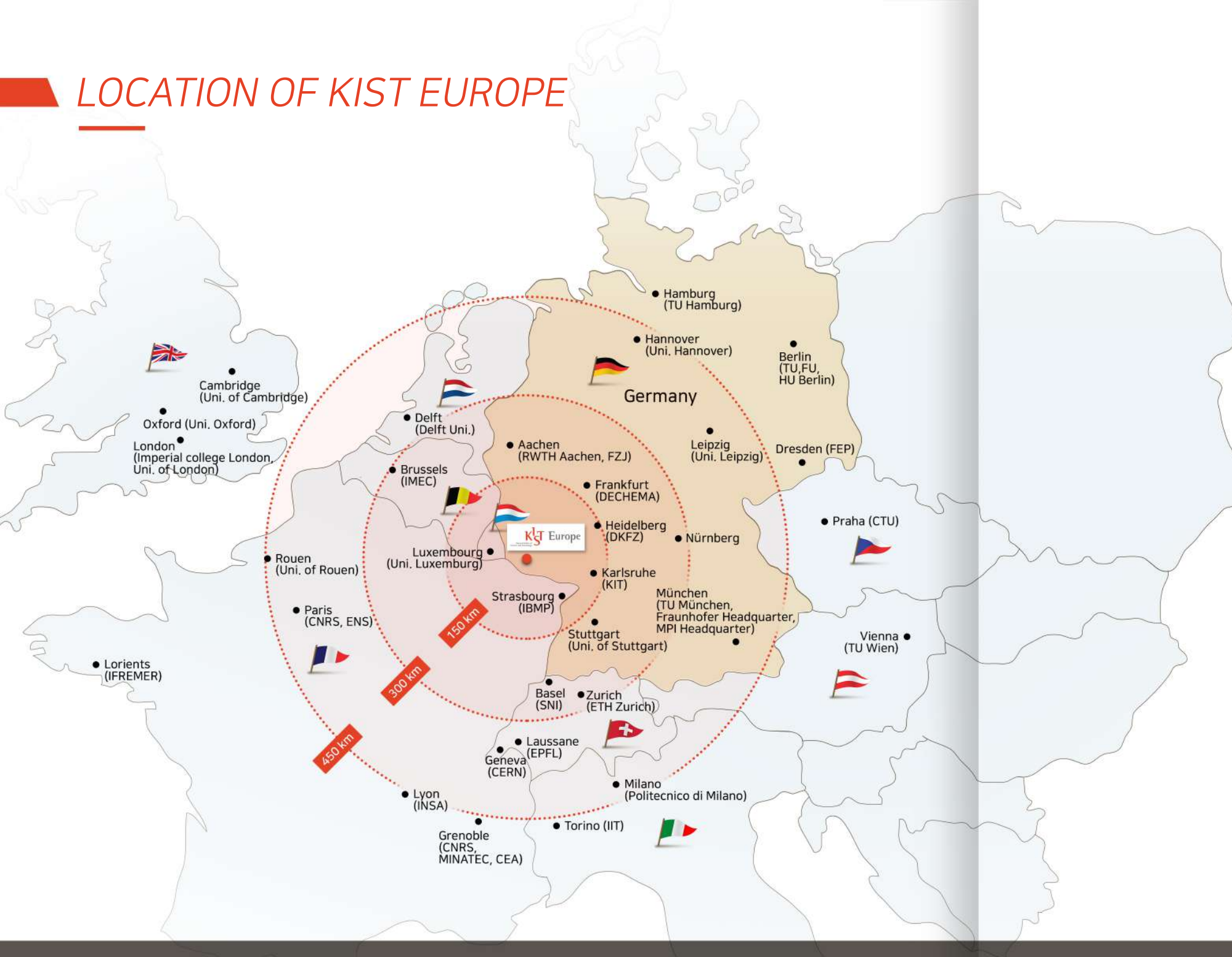
### \* MoU Between Faculty/Group of each party

- KIST Europe : Biosensor & Materials Group
- Hanyang University : Department of Energy Engineering
- University of Saarland : Natural Science and Technology Faculty





# LOCATION OF KIST EUROPE



## Imprint

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