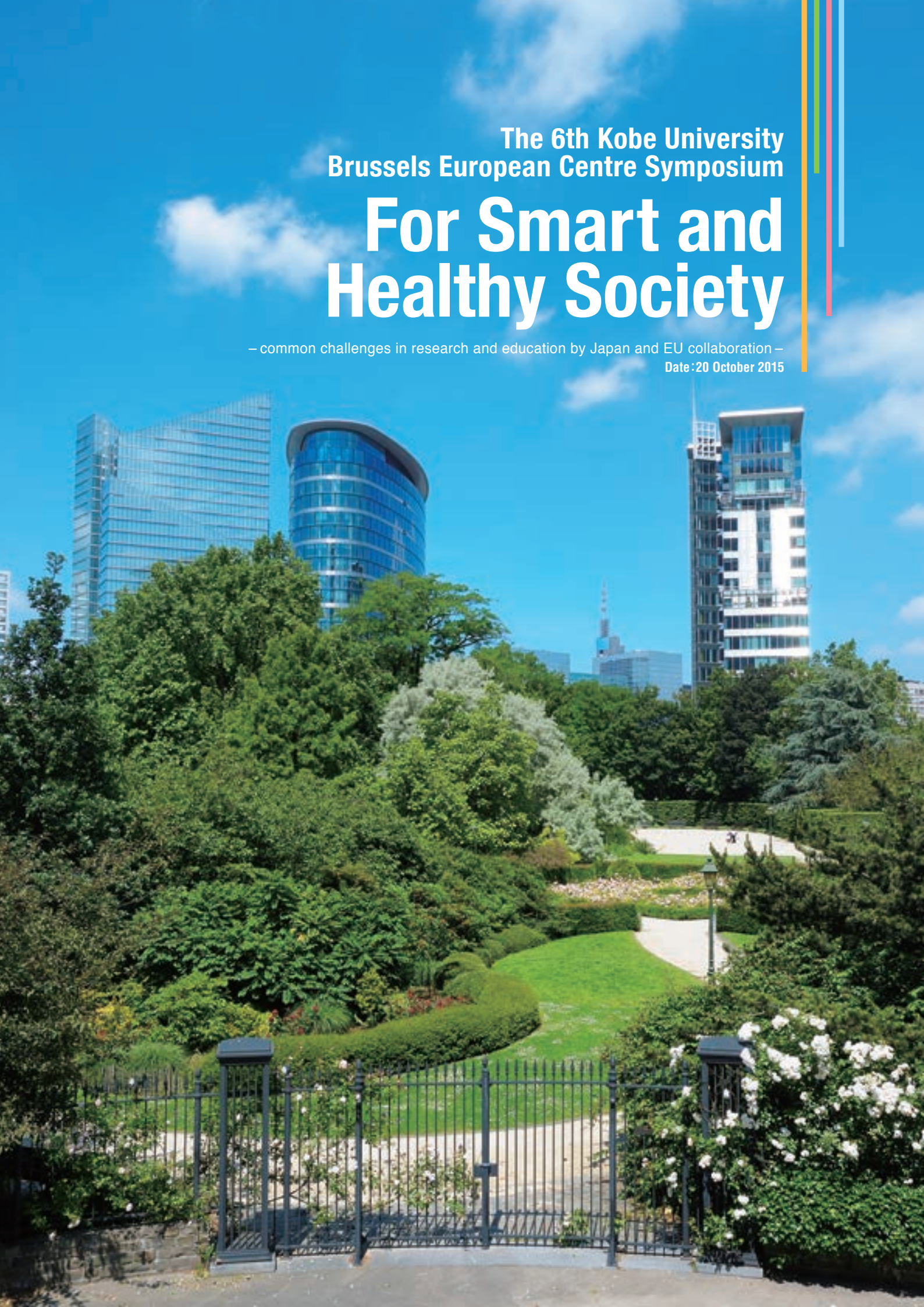

The 6th Kobe University Brussels European Centre Symposium

For Smart and Healthy Society

– common challenges in research and education by Japan and EU collaboration –

Date : 20 October 2015

Preface

I am pleased to present this report on the 6th Kobe University Brussels European Centre (KUBEC) Symposium “For Smart and Healthy Society - common challenges in research and education by Japan and EU collaboration-”, which was held in Brussels on 20 October 2015. KUBEC has been holding an annual symposium in Brussels since its establishment in 2011. Since then, we have been striving to expand our academic network in Europe and to raise the profile of Kobe University and other Japanese universities. In this regard, we place an emphasis on our “visibility” in Europe by holding a number of academic workshops and seminars at KUBEC or at partner institutions as well as the annual symposium in Brussels, which features guest speakers from both European institutions and Japanese universities.

The theme of the 6th symposium, “For Smart and Healthy Society - common challenges in research and education by Japan and EU collaboration-” focused on the shared challenges Japanese and EU societies face as they pursue future development. The latest research results and applications of ICT, Nanoscience for Material Technology, and In Vitro Modeling of the Human-Microbial Gastrointestinal Interface were introduced by both Japanese and European researchers in the hope of establishing future collaboration using advanced technology for each project. Furthermore, we also discussed perspectives on interdisciplinary research and education in Economics and Law as taught in various countries as an example of the globalisation of academic society, welcoming prominent researchers from around the world. As a result of this symposium, collaborative projects are under discussion or have already begun. I hope this event will enhance EU-Japan research collaboration for the betterment of our societies.

Hiroshi Takeda
President
Kobe University

The 6th Kobe University Brussels European Centre Symposium

For Smart and Healthy Society

- common challenges in research and education by Japan and EU collaboration -

Date and Time : Tuesday 20 October 2015 9:30-18:00
Place : Thon Hotel EU Rue de la Loi 75, B-1040, Brussels, Belgium
Organiser : Kobe University

Opening [9:30-10:00]

MC : Prof. Matsuto Ogawa, Executive Vice President, Kobe University
Opening addresses : Prof. Hiroshi Takeda, President, Kobe University
H.E. Mr. Keiichi Katakami, Ambassador of Japan to the European Union
Mr. Kostas Glinos, Head of Unit in the International Cooperation Directorate,
Directorate–General Research and Innovation, European Commission

Session 1 [10:00-13:30]

ICT and Smarter Society

Session 2 [10:00-13:30]

Nanoscience for Material Technology and Energy Conversion

Session 3 [14:30-18:00]

Perspectives on Interdisciplinary Research and Education of Economics and Law

Session 4 [14:30-18:00]

Recent Advances in In Vitro Modeling of the Human-Microbial Gastrointestinal Interface

Opening Speech

Prof. Hiroshi Takeda

President of Kobe University

Distinguished guests, ladies and gentlemen, it gives me great pleasure to welcome all of you to the 6th Symposium of Kobe University Brussels European Centre.
Today we are fortunate to have many distinguished guests in attendance, and I would like to begin by expressing my sincere gratitude in particular to our honourable guests, His Excellency Ambassador Keiichi Katakami, Mission of Japan to the European Union, and Mr. Kostas Glinos, Head of Unit, International Cooperation Directorate, Directorate-General for Research and Innovation of the European Commission. I am deeply grateful for everyone's participation today.
Since its inception in 2011, Kobe University's annual symposium in Brussels has been an important occasion for members of Japanese and European institutions to discuss collaboration in research and education. As the president of Kobe University newly appointed from the 1st of April this year, I sincerely hope that our symposium continues to provide valuable opportunities for international dialogue.
The 6th Symposium today promises to follow this trend. As the title of this symposium suggests, the building of smart and healthy societies is a pressing issue both for the EU and for Japan. In our time, Japan and the EU member states share many societal problems, ranging from aging population to increasing demand for energy supply in urbanized areas. Smartness and healthiness become highly relevant to our communities precisely because such qualities can effectively address the new demands of our communities, be they in the fields of technology, health care, or market economy.
To make their social infrastructures smarter and their communities healthier, both the EU and Japan have been implementing various initiatives respectively under Europe 2020 and the revised Growth Strategy. In this effort, however, institutions of higher education have no small part to play. As the very initiatives such as the EU's Horizon 2020 and Japan's Innovation 2020 make it clear, universities–on their own or together with the private sectors–have the resources to produce influential innovations for the betterment of society. It is my hope that today we see researchers from Europe and Japan present their cutting-edge research in a variety of fields and pave the way for future collaboration.
I thank you all again for participating in today's Symposium.

H.E. Mr. Keiichi Katakami

Ambassador of Japan to the European Union

Prof. Hiroshi Takeda,
Mr. Kostas Glinos from European Commission,
Distinguished guests,
Ladies and Gentleman,
Good morning to every one of you.
It's a great honour to be here at the 6th Kobe University Brussels European Centre Symposium.
I would first like to extend my appreciation and thank those who have organised this event.
Technology and science have the power to open doors and open our eyes. They can have a profound effect on how we live our lives or how we understand the world around us.
Earlier this month, two Japanese scientists were awarded the Nobel Prize in recognition of their ground-breaking work in the fields of basic science and medicine.
Takaaki Kajita's experiments in quantum physics tapped cosmic rays to solve the enigma of the neutrino, showing that it oscillates and has mass. Indeed, now we know that the collective weight of neutrinos is equal to the collective weight of the stars.
And, thanks to Satoshi Omura's life-long study of the bacteria that attack parasitic worms, drugs have been developed against devastating diseases that have plagued a third of the world's population, depriving countless children and adults from enjoying good health and participating fully in their communities and economies.
Creating a climate that encourages discovery and innovation in science and technology is central to economic growth and wellbeing.

In Japan, there have been some interesting developments recently that show our commitment to creating an optimal environment for this to happen.
PM Abe has recently announced the second stage of his “Abenomics” reform plan to boost the Japanese economy, in which investment in science and technology will play an important role.
In next year, Japan will unveil its Fifth Science and Technology Basic Plan, covering the next 5-year period. It will consist of three pillars :The first pillar is dedicated to “systemizing technologies for the future”.
The second pillar aims at removing various barriers including intergenerational barriers, barriers between industry, academia and government, and across national borders in order to respond effectively to all future changes.
The third pillar aims to encourage the development of a sort of ecosystem for human resources, technologies and capital in order to generate new businesses and thus revitalize Japan’s regions.
Thus, today's topic of a “Smart and Healthy Society” is a timely and important one for Japan, and I am fully confident that the combined contributions from academics, students and industry at this symposium will give new momentum to Japan-EU collaboration in the fields being covered today.
In May of this year, I attended the 23rd Japan-EU summit in Tokyo. During this summit, Japanese and EU leaders reaffirmed their commitment to advancing further cooperation in the science and technology fields, and endorsed the Joint Vision towards a new strategic partnership.
The Japan-EU strategic partnership is based on the fact that our two regions face similar challenges in a wide range of areas, including healthcare, energy, and environmental policy to name a few. Greater cooperation between Japan and the EU in research and innovation will allow us to promote the excellence of our research, boost the competitiveness of our industries, and address common and global challenges together.
The Joint Vision endorsed by our governments is underpinned by three aspects:
First, it acknowledges to substantially increase Japan-EU cooperation in research and innovation in ICT, aeronautics, and materials – including critical raw materials. In the future we hope to expand this cooperation to encompass health, medical research, the environment, energy and high-energy physics in recognition of the strategic significance of boosting cooperation in these fields.
Second, the Joint Vision recognizes the importance of constantly seeking to promote opportunities to increase mobility of researchers between Japan and the EU.
Finally, in order to fully exploit our cooperation potential, this Joint Vision highlights the importance of creating more simplified, mutually acceptable mechanisms for the joint funding of research and innovation projects.
In the Japan-EU Summit this spring, cooperation through the EU’s Horizon 2020 and also the seven joint projects by the two partners was confirmed, but *greater* efforts are needed to enhance our cooperation in *all* areas, and we must endeavour to make the Japan-EU relation stronger than before.
In our collaboration for technological innovation and to further scientific knowledge, we must act with a sense of responsibility. Japan and the EU have the ability to realise a vibrant new society that is full of economic and social opportunity, not just for us, but for the whole world.
Today’s symposium offers an excellent opportunity for the academics, researchers and innovators gathered here from Japan and all over the EU to come together to discuss how to enhance cooperation, and to work towards smarter and healthier societies.
From this perspective I wish you every success for a fruitful exchange of views today, and I look forward to hearing the results of this symposium.
Thank you.

Mr. Kostas Glinos

Head of Unit International Cooperation Directorate Directorate-General
for Research and Innovation

Your Excellency, Ladies and Gentlemen,
First of all, I would like to thank the organiser of the conference, Kobe University, for giving me the opportunity to present Horizon 2020 and the opportunities for Japanese researchers, research organisations and companies to participate. This symposium comes very timely as we have just published the Horizon 2020 Work Programme for 2016-2017 with new open calls for proposals.
I would also like to congratulate the Japanese research community for the two 2015 Nobel Prizes that have just been awarded to Japanese scientists–in Physics to Professor Takaaki Kajita (University of Tokyo) and in Physiology or Medicine to Professor emeritus Satoshi Ōmura (Kitasato University).
EU-Japan relations have developed steadily over the past two decades. The EU and Japan share the same values, we face many of the same societal challenges (energy security, access to critical raw materials, ageing populations) and defend a similar approach to key international objectives such as security, development cooperation and combating climate change. Japan is in many ways one of

Europe's closest partners on the international arena.

This is why we believe there is a strong potential for strengthened cooperation with Japan in research and innovation.

In May this year a new Strategic Partnership in Research and Innovation (R&I) was adopted and endorsed by the EU-Japan Summit in Tokyo. This Strategic Partnership is based on actions in various areas:

- to deepen strategic cooperation by frequent consultation at multiple levels;
- to consolidate framework conditions that facilitate collaboration: the establishment of mechanisms for the joint funding of research and innovation projects such as with Japan Science and Technology Agency (initially in the areas of materials and power electronics), and measures to enhance the mobility of researchers, such as the recently signed cooperation arrangement between the European Research Council (ERC) and the Japan Society for the Promotion of Science, and opportunities offered by the Horizon 2020 Marie-Sklodowska Curie Actions (MSCA);
- to deepen cooperation in thematic areas of strategic importance: ICT, Aeronautics, and Materials including Critical Raw Materials - and to strengthen cooperation in areas such as Health, Energy, Environment and High-energy physics;
- to extend our partnership to close consultation and possible coordination on Science, Technology and Innovation policies such as Open Science; and
- to promote the role of support activities and public engagement.

Both sides are committed to delivering on the new Strategic Partnership in R&I. From our side we strongly encourage an increased level of participation of Japanese researchers and research organisations in the EU's Horizon 2020 programme in view of the recently published new open calls.

Horizon 2020 (2014-2020) is the largest and most open research and innovation funding programme in the world with a budget of nearly 80 billion euros. Horizon 2020 is open to the participation of researchers and research institutions from anywhere in the world, to extend the frontiers of scientific knowledge, tackle challenges that affect us all and make industries more competitive.

The focus of this symposium is on "smart and health society", where topics such as ICT, applied nanoscience, interdisciplinary research and education of economic and law, and In Vitro modelling of the human-microbial gastrointestinal interface are addressed. These are all important themes in Horizon 2020 and areas where Japanese researchers already cooperate substantially with European teams, in particular in the field of ICT and Materials research.

Technically, there are two ways to cooperate with industrialised countries such as Japan in Horizon 2020:

The "General Opening" means that any organisation from any country can join a consortium and submit a proposal. We call this also the 'bottom up' approach. The evaluation is based solely on the quality of the proposal submitted by the consortium. In the previous framework programme - FP7, there have been 116 Japanese participations in 101 projects, 358 MSCA grantees and 14 ERC grantees. There have further been around 160 participations of 70 different Japanese companies based in Europe. In Horizon 2020, there have so far been 24 Japanese participations in 18 projects, and an additional 15 MSCA grantees.

In the "Targeted Opening" approach, international cooperation with specific countries is either encouraged or required in the proposal. We call this the 'top down' approach. There are 23 call topics in Work Programme 2016-17 that specifically encourage cooperation with Japan in areas such as ICT, transport, research infrastructures, digital security, and nanotech and advanced materials to mention but a few.

One way of implementing this targeted opening is through "coordinated calls". The "coordinated calls" are organised jointly with funding organisations from third countries. This has worked well with Japan for five calls in FP7 in the fields of ICT, aeronautics, energy and materials/critical raw materials. In addition, during the first year of Horizon 2020, two additional coordinated calls were launched–one in ICT and one in Aeronautics–and there will be another two coordinated calls launched this coming year in the fields of ICT and Health. These calls have been launched together with Japanese ministries and agencies: the Ministry of Economy, Trade and Industry (METI) in aeronautics; the Ministry of Internal Affairs and Communication (MIC) in ICT; the New and Industrial Technology Development Organisation (NEDO) in new energy technologies; and the Japan Science and Technology Agency (JST) in new materials and critical raw materials.

In conclusion, Horizon 2020 is 'Open to the World' – and we would be pleased if more Japanese researchers and research institutions will take the opportunity to join the cooperation for the benefit of us all.

I am delighted to see that the organiser of this conference - Kobe University - already has participated in projects in the EU's framework programme, for instance in the area of "Systemic seismic vulnerability and risk analysis for buildings, lifeline networks and infrastructures safety gain".

I would also suggest that researchers and research organisations present at the symposium take a closer look at the various calls for proposals that have just been opened in Horizon 2020 Work Programme 2016-17. Most of the calls are open to Japanese participation, and as already mentioned many call topics specifically target Japanese participation.

I would again like to thank the organisers for providing me this opportunity to present our strategic cooperation with Japan in research and innovation, and the participation opportunities provided by Horizon 2020.

Thank you for your attention.

Session 1 [10:00-13:30]

ICT and Smarter Society

Chair

Prof. Masahiko Yoshimoto
Graduate School of System Informatics, Kobe University, Japan

Speakers

Prof. Seiichi Ozawa
Graduate School of Engineering, Kobe University, Japan

Dr. Noriyuki Murakami
NARO Hokkaido Agricultural Research Center, Japan

Prof. Cesare Alippi
Information processing systems, Politecnico di Milano, Italy

Prof. Philippe Lalanda
Grenoble University, France

The utilization of ICT (Information Technology) in various fields and the integration of technologies are crucial areas for the promotion of science, technology and innovation. ICT contributes to the realization of a reliable, safe, secure, comfortable, and highly efficient social system (Smarter Society) through the following three methods:

• Accurately collecting information about humans, environmental information, and information embodied in objects and phenomena in the real world
• Processing (accumulation, search, conversion, analysis, recognition, and planning) the collected big data in the cyber world
• Producing appropriate physicochemical effects (control and actuation) on the real world

The above scheme is called Cyber-Physical Systems technology. It provides actual solutions for social issues such as traffic control, environment problems, energy management, city area infrastructure, agriculture and healthcare. This session was dedicated to sharing our knowledge, current topics of research and developments in Cyber-Physical Systems in Japan and Europe.

Professor Masahiko Yoshimoto introduced the core research team for Cyber-Physical Systems which is part of "The Organization of Advanced Science and Technology" in Kobe University. He also presented on "A low-power ECG–SoC (System-on-a-Chip) with normally-off computing for wearable healthcare systems", one of the team's recent research topics.

Following his introduction, four researchers introduced innovative technologies.

Professor Seiichi Ozawa presented an image-sensing method for smart agriculture to develop more reliable systems for earning high-yield and high-quality products. The growth status and yields of soybeans in outdoor environments were acquired using this method and used for agricultural big data mining.

Doctor Noriyuki Murakami proposed a robotic cabbage harvester to mechanize selective harvesting operations. A neural network technique was utilized to classify the cabbage head and leaves and template matching was applied to estimate the cabbage position and size.

Professor Cesare Alippi focused on intelligence and fault diagnosis in cyber-physical systems. He demonstrated how the use of intelligence can boost the next generation of embedded and cyber-physical-based applications, including environmental monitoring.

Finally, **Professor Philippe Lalanda** presented iCasa, a software framework for the development and execution of multiple home applications. The use of this framework was illustrated on a health application for the home, called actimetrics.

After the presentations, all participants discussed these novel technologies and their applications, and explored the possibility for collaboration among those projects.

Prof. Masahiko Yoshimoto chair

Graduate School of System Informatics, Kobe University, Japan

Masahiko Yoshimoto is a Professor and Dean of the Graduate School of System Informatics, Kobe University.
Prof. Yoshimoto worked over 20 years in the industry (Mitsubishi Electric Co.) where he has held the positions of circuit designer, architect, and R&D project leader in the domains of advanced SRAM, video compression VLSI and multimedia communication system-on-a-chip. He now conducts research in the fields of ubiquitous media VLSI systems for IoT sensor node, including an ultra low power application specific processor and a low power dependable SRAM circuit. He has authored some 200 papers in international journals and conferences. He also holds about 80 registered patents. He has served on the program committee of the IEEE International Solid State Circuit Conference from 1991 to 1993. From 2009 to 2010, he was Chair of IEEE SSCS (Solid State Circuits Society) Kansai Chapter.

"A Low Power, Normally-Off ECG-SoC (System-on-a-Chip) with Noise Tolerant Heart Rate Extractor for Wearable Healthcare Systems"

Abstract: To prevent lifestyle diseases, wearable bio-signal monitoring systems for daily life monitoring have attracted attention. Wearable systems have strict size and weight constraints, which impose significant limitations of the battery capacity and the signal-to-noise ratio of bio-signals.
This paper describes an electrocardiograph (ECG) monitoring SoC using a non-volatile MCU (NVMCU) and a noise tolerant instantaneous heart rate (IHR) monitor. The novelty of this work is the combination of the non-volatile MCU for normally-off computing and a noise-tolerant-QRS (heart beat) detection algorithm to achieve both low-power and noise tolerance. To minimize the stand-by current of MCU, a non-volatile flip-flop and a 6T-4C NVRAM are employed. The proposed accurate heart beat detector employs a coarse-fine autocorrelation and a template matching technique. Accurate heart beat detection also contributes to system level power reduction because the active ratio of ADC and digital block can be reduced using a heart beat prediction. Then, at least 25% active time can be reduced. Measurement results show the fully integrated ECG-SoC consumes 6.14μA including 1.28μA non-volatile MCU and 0.7μA heart rate extractor.

Prof. Seiichi Ozawa

Graduate School of Engineering, Kobe University, Japan

Seiichi Ozawa is a Professor in the Department of Electrical and Electronic Engineering at the Graduate School of Engineering, Kobe University, Japan. He received his Doctor of Engineering from Kobe University. He is an associate editor of three international journals including IEEE Trans. on Neural Networks and Learning Systems, a member of Neural Networks Technical Committee of IEEE CIS, a governing board member of the Asia Pacific Neural Network Assembly, and the vice-president of the Japanese Neural Network Society. His current research interests include machine learning, big data analytics, online learning, pattern recognition, cybersecurity, social networks, and smart agriculture.

"Image Sensing Method for Smart Agriculture"

Abstract: Smart Agriculture is a new concept to promote high-productivity in agriculture using ICT technologies. The final goal of Smart Agriculture is to produce high-yield and high-quality agricultural products that are robust and efficient under various environments. In Smart Agricuture, not only environmental information of fields but also growth information of agricultural plants should be first sensed to understand plant status. Then, the captured information is stored in a database and used for mining useful knowledge to control temperature, soil moisture, quantities of fertilizer and agricultural chemical, and so on. In this talk, we present an image sensing approach to acquiring growth status and yields of soybeans under outdoor environments. Obviously, sensing information in outdoor environments is quite challenging compared with indoor environments. However, if such image sensing systems are deployed with low costs in many firms, it would result in collecting a large amount of information on growth status and yields; that is, it would lead to "Agricultural Big Data." Mining from such big data allows us to develop more reliable systems for earning high-yield and high-quality products under various environments. We report our first results for this ultimate goal.

Dr. Noriyuki Murakami

NARO Hokkaido Agricultural Research Center, Japan

Senior Researcher at NARO Hokkaido Agricultural Research Center engaging in High Efficient Paddy Rotation System and IT Farming, Japan. Awarded Master of Agricultural Engineering of Tokyo University of Agriculture and Technology, Japan and PhD from Kyoto University, Japan in 1991 and 2000, respectively. After working for the National Agricultural Research Center as researcher, Japan, he moved to Hokkaido Agricultural Experiment Station (reorganized as the Hokkaido Agricultural Research Center in 2006) in 1998. The research focused on highly efficient agricultural production systems and IT farming.

"Robotic cabbage harvester"

Abstract: Harvesting heavy vegetables such as cabbages is a labor intensive, tedious operation. Moreover, mechanical harvesting is expected to be automated due to a decrease in the number of farmers in Japan.
A robotic cabbage harvester was developed to mechanize selective harvesting operations. A gripper for picking cabbages which is mounted on the 4 DOF polar coordinate hydraulic drive manipulator has four fingers, two fingers for holding the cabbages, and the others for cutting the stem with blade which is attached to the finger tips. The operation is done by dual actions by those fingers: holding the cabbage head and cutting the stem.
A detection technique of harvest targets is an essential element for the harvesting robot. A image processing algorithm was developed to detect the head of cabbage in the field under natural lighting conditions. Neural Network was effective to classify the cabbage head and leaves and Template Matching was applied to estimate the cabbage position and size.
As a result of field experiments, it was discovered that the success rate for picking mature cabbages was 40 to 71% and that 60 to 71% of their stems and leaves were successfully cut.

Dr. Cesare Alippi

Information processing systems, Politecnico di Milano, Italy

CESARE ALIPPI received a degree in electronic engineering cum laude in 1990 and a PhD in 1995 from Politecnico di Milano, Italy. Currently, he is a Full Professor of information processing systems with Politecnico di Milano. He is an IEEE Fellow, Distinguished lecturer of the IEEE CIS, Board Member of INNS, Vice-President for education of IEEE CIS, Associate editor (AE) of the IEEE Computational Intelligence Magazine, past AE of the IEEE-Trans. Instrumentation and Measurements, IEEE-Trans. Neural Networks, and member and chair of other IEEE committees. His current research activity addresses adaptation and learning in non-stationary environments and Intelligence for embedded systems.

"Intelligence for cyber-physical and embedded systems"

Abstract: The emergence of non-trivial embedded sensor units and cyber-physical systems has made possible the design and implementation of sophisticated applications where large amounts of real-time data are collected, possibly to constitute a big data picture as time passes. Acquired data are then processed at local, cluster-of-units or server level to take the appropriate actions or make the most suitable decision. Within this framework, intelligence mechanisms play a key role to provide systems with advanced functionalities. Intelligent mechanisms are needed to optimally harvest and manage the residual energy, identify possible faults affecting some sensors within a model-free framework, solve the compromise between accuracy and computational complexity, and guarantee appropriate performances within an evolving, time invariant environment.

The talk will mainly focus on Intelligence and Fault diagnosis in cyber-physical systems and show how the use of intelligence can boost the next generation of embedded and cyber-physical-based applications, a generation whose footprint is already around us. Sophisticated environmental monitoring scenarios deployed on the Alps for landslides and rock toppling will constitute the leitmotiv of the presentation.

Prof. Philippe Lalanda

Grenoble University, France

Philippe Lalanda is a Professor in computer science at Grenoble University.
He completed his PhD in Artificial Intelligence at INRIA under the direction of Jean-Paul Haton. He then turned to the links between AI and robotics at Stanford University.
Prof. Lalanda worked ten years in the industry (Dassault, Thales, Schneider) where he held the positions of programmer, architect, and R&D project leader in the domains of software architecture, software product line and pervasive computing.
Prof. Lalanda now conducts research in the fields of autonomic and pervasive computing. He has authored some 100 papers in international journals and conferences and supervised 17 PhDs. He also served as a reviewer in a number of conferences (Percom, icac, icse, ieee software, etc.).

"iCasa, a software framework for the development and execution of multiple home applications"

Abstract: Providing services enhancing the potential of the elderly and patients to live and cope at home is today a major challenge, both in economic and societal terms. Healthcare costs are booming and the aging of the population only reinforces this trend. Also, people usually want to stay in their own homes and be independent for as long as they can. It is thereby urgent to develop a range of accommodation and support that are appropriate to individuals remaining at home.
In this context, advances in pervasive computing are very encouraging and exciting. The proliferation of smart, communication-enabled devices is indeed opening up many new opportunities in the home care domain. Pervasive Computing is a vision for next-generation computer systems that infuse into real world environments. It is fundamentally characterized by the connection of things in the world with computation.
However, developing pervasive user-centric applications continues to be quite a challenge. Such applications have to handle devices characterized by considerable heterogeneity and volatility. Applications do not control devices lifecycle, which means that devices can come and go their own way. Also, pervasive data present different formats, relevance, and preciseness.
We believe that systematic software engineering tools are needed to effectively develop and maintain pervasive applications in the homes. This is the challenge taken up in this presentation. Specifically, we propose iCasa, a framework to develop pervasive applications. The use of this framework is illustrated on a heath application for the home, called actimetrics.

Session 2 [10:00-13:30]

Nanoscience for Material Technology and Energy Conversion

Chair

Prof. Minoru Mizuhata

Department of Chemical Science and Engineering,
Graduate School of Engineering, Kobe University, Japan

Speakers

Prof. Franz Faupel

Institute for Materials Science, Christian-Albrechts-Universität zu Kiel, Germany

Dr. Andrey Shukurov

Faculty of Mathematics and Physics, Charles University in Prague, the Czech Republic

Mr. Arturo Melendez-Ceballos

Institute de Recherche de Chimie Paris, France

Mr. Kyohei Kanki

Department of Chemical Science and Engineering,
Graduate School of Engineering, Kobe University, Japan

This session consisted of 5 lectures relating to nanoscience in materials science and energy conversion from Germany, Czech Republic, France, and Japan.

Professor Franz Faupel of the Faculty of Engineering, Christian Albrechts University of Kiel talked about his research on advanced nanomaterials for functional applications in his laboratory and University. His research is part of the research focus of KiNSIS (Kiel Nano, Surface and Interface Science, http://www.kinsis.uni-kiel.de), which includes particulate nanocomposites with applications ranging from plasmonics to photoswitchable devices, smart materials and multiferroics such as ultrasensitive magneto–electric sensors for biomagnetic interfaces and highly fatigue resistant superelastic shape memory films for stents and energy harvesting, materials with extreme porosity and hosts of unique properties based on tetrapodal zinc oxide, ultrahigh capacity anodes for Li-ion batteries made of porous silicon, and various nanomaterials for controlling cell behavior.

Doctor Andrei Shukurov, Associate Professor of Charles University in Prague presented his research on plasma-based methods for nano-structuring of surfaces. Low-temperature plasma is well known as a powerful tool for surface modification. His lecture reviewed the research activities at the Department of Macromolecular Physics, Faculty of Mathematics and Physics, Charles University in Prague in the field of plasma-based surface modification. Basics of the plasma polymerization processes and magnetron sputtering were considered with the main focus on fabrication of functional nanostructured materials. He also presented on growth of polymeric nano-islands and plasma-tailoring of their structure. Utilization of nano-structured surfaces in the field of optically active materials, super-hydrophobic surfaces or in biomedical applications was also discussed.

After the coffee break, **Professor Minoru Mizuhata** of the Graduate School of Engineering, Kobe University talked about fabrication of nanocomposites using electrochemistry and solution chemistry. Porous silicon (PSi) is fabricated by anodic oxidation of Si wafer in HF/organic solvent solution. Pore size is controlled by resistivity of Si wafer and reaction condition. He fabricated various oxide and sulphide composites with porous silicon such as CeO_2 / PSi, TiO_2 / PSi, and ZnS / PSi. In this lecture, Professor Mizuhata introduced the fabrication of these thin films deposited on the surface of pores in porous silicon without the plugging of pores by electrodeposition. For TiO_2 / PSi, he tried to apply on the anode materials of lithium-ion battery which demonstrated a large energy density with alloying reaction of Si. TiO_2 was deposited into the porous structure. For CeO_2 / PSi, he found the epitaxial growth of CeO_2 in the PSi of which luminescence intensity sharply increased. For ZnS / PSi, the PL spectra due to the ZnS / PSi composites had two peaks at 430 (blue) and 530 nm (green). The PL intensity decreased with an increase of current density, hence PL intensity decreased in the case of high current density.

The final two presentations were from graduate students.

Mr. Arturo Meléndez-Ceballos, graduate student at Institut de Recherche de Chemie Paris presented on activities in the field of high temperature fuel cells, in particular MCFCs. High temperature fuel cells (HTFC) as solid oxide fuel cells (SOFC) and molten carbonate fuel cells (MCFC) are electrochemical devices that can produce electricity from a fuel (hydrogen, methane, bio-gas, syngas among others) and oxygen from air by means of an electrochemical reaction that takes place at the cell. The working temperature of this type of cells is in the range of 500 to 1000 °C which enables the use of less expensive catalyzers than those used in low temperature fuel cells such as proton exchange membrane fuel cell (PEMFC) or direct methanol fuel cell (DMFC). In addition, HTFC have a high efficiency (≈ 50 %) and they can reach up to 80 % when used in cogeneration with a turbine or for water heating. These fuel cells constitute a promising technology for clean generation of electricity in the MW scale. He also presented recent research about the viability of carbon dioxide capture and storage using MCFC type cells with important implications in environmental remediation of air and reduction of CO_2 emissions.

Mr. Kyohei Kanki, a graduate student at the Kobe University Graduate School of Engineering, presented on CO_2 absorption behavior of ceramics / molten salts composites at high temperatures. His research related to CO_2 absorption behaviors of Li_4SiO_4 at lower temperatures. It was found that samples whose surface was modified with ball milling method under an Ar atmosphere showed a tendency to increase the surface area and increase of Si dangling bond. It was found that there are two different absorption processes: a chemisorption at the surface ($T<773$ K) and a bulk diffusion ($T>773$ K). Furthermore, it was found that carbonate coexistence and grinding by ball milling made the activation free energy decrease.

Prof. Franz Faupel

Institute for Materials Science, Christian-Albrechts-Universität zu Kiel, Germany

Franz Faupel received his Ph.D. in physics from the University of Göttingen in 1985. From 1987 to 1988, he was postdoctoral fellow at the IBM Th. J. Watson Research Center in Yorktown Heights, and he got his habilitation from the University of Göttingen in 1992. Since 1994, he holds the Chair for Multicomponent Materials within the Faculty of Engineering at Christian Albrechts University. Faupel published more than 300 peer reviewed publications and is listed in the Web of Science with an h-index of 38. His research interests include functional nanocomposites, diffusion, metallic glasses, metal-polymer interfaces, and plasma deposition.

"Research on advanced nanomaterials for functional applications at Kiel University"

Abstract: The research groups at the Institute for Materials Science in Kiel (http://www.tf.uni-kiel.de/matwis) focus on advanced nanomaterials for functional applications and are part of the research focus KiNSIS (Kiel Nano, surface and interface science, http://www.kinsis.uni-kiel.de). Examples of current research include particulate nanocomposites with applications ranging from plasmonics to photoswitchable devices, smart materials and multiferroics, such as ultrasensitive magnetoelectric sensors for biomagnetic interfaces and highly fatigue resistant superelastic shape memory films for stents and energy harvesting, materials with extreme porosity and hosts of unique properties based on tetrapodal zinc oxide, ultrahigh capacity anodes for Li-ion batteries made of porous silicon, and various nanomaterials for controlling cell behavior. Synthesis methods span from physical vapor deposition to novel wet chemical approaches like a Leidenfrost reactor. Tailoring of the functional properties benefits largely from clean room facilities and advanced analytical techniques, in particular, high resolution transmission electron microscopy, magnetic domain imaging, and measurement of the magnetization dynamics. The Institute cooperates closely with the Fraunhofer Institute for Silicon Technology and the Helmholtz Center Geesthacht.

Dr. Andrey Shukurov

Faculty of Mathematics and Physics, Charles University, the Czech Republic

Associate professor at the Department of Macromolecular Physics, Faculty of Mathematics and Physics, Charles University in Prague. Awarded Ing from the State University of Chemistry and Technology in Ivanovo, Russia in 1995, PhD and Doc from the Charles University in Prague, Czech Republic in 2003 and 2011, respectively. In 2002-2003, joined University of Illinois at Chicago, USA as a research assistant and in 2005-2007 worked at Nagoya University, Japan as an assistant professor. His research focuses on fabrication of novel materials with nanoscale structure by low-temperature plasma based methods.

"Plasma-based methods for nano-structuring of surfaces"

Abstract: Low-temperature plasma is very well known as a powerful tool for surface modification. It may (and often it does) offer significant advantages over conventional technologies. This lecture reviews the research activities performed at the Department of Macromolecular Physics, Faculty of Mathematics and Physics, Charles University in Prague in the field of plasma-based surface modification. Basics of plasma polymerization processes and magnetron sputtering will be considered with the main attention focused on fabrication of functional nanostructured materials. Application of magnetron-based Gas Aggregation Sources to production of beams of nanoparticles will be discussed. Examples will be given including deposition of metal nanoparticles as well as particles of hydrocarbon, nitrogen-containing and fluorocarbon plasma polymers. Methods of preparation of metal / plasma polymer nanocomposites will be presented including fabrication of sandwich-type and dual-scale roughness coatings. Growth of polymeric nano-islands and plasma-tailoring of their structure will be also presented. Utilization of nano-structured surfaces in the field of optically active materials, super-hydrophobic surfaces or in biomedical applications will be discussed.

Prof. Minoru Mizuhata chair

Department of Chemical Science and Engineering,
Graduate School of Engineering, Kobe University, Japan

Professor Minoru MIZUHATA was born in 1964 in Hyogo, Japan. He graduated from the Department of Industrial Chemistry, Faculty of Engineering, Kobe University in 1987, and entered the Graduate School of Science and Technology, Kobe University. He earned his Master's Degree (Engineering) in 1989, and Doctoral Degree (Science) in 1992. He was employed by the Government Industrial Research Institute, Osaka (currently National Institute of Advanced Industrial Science and Technology) in 1992, and moved to Kobe University in 1996 as a Research Associate. His research area has been in Inorganic Chemistry, Electrochemistry, and Interface Science, and experience in R&D on fuel cell, electrolyte solution, and active materials, and nanomaterials. He was promoted to Associate Professor in 2005, and Professor in 2011. He is a member of the American Chemical Society, The Royal Society of Chemistry (Chartered Chemist), Chemical Society of Japan, and The Electrochemical Society, Inc.

"Fabrication of Nanocomposite using Electrochemistry and Solution Chemistry"

Abstract: Porous silicon (PSi) is fabricated by anodic oxidation of Si wafer in HF / organic solvent solution. Pore size is controlled by resistivity of Si wafer and reaction condition. We have fabricated various oxide and sulphide composite with porous silicon; such as CeO_2 / PSi, TiO_2 / PSi, and ZnS / PSi. In general, the chemical reaction in an aqueous solution is suitable to deposit thin film among complex structured substrate because of its short mean free path of reactive species. In this lecture, we introduce the fabrication of these thin films deposited on the surface of pores in porous silicon without the plugging of pores by electrodeposition. For TiO_2 / PSi, we tried to apply on the anode materials of lithium-ion battery which demonstrated large energy density with alloying reaction of Si. TiO_2 was deposited into porous structural For CeO_2 / PSi, we have found the epitaxial growth of CeO_2 in the PSi of which luminescence intensity was extremely increased. For ZnS / PSi, the PL spectra due to the ZnS/PSi composites had two peaks at 430 (blue) and 530 nm (green). The PL intensity was decreased with an increase of current density, hence PL intensity was decreased in the case of high current density. We will introduce the experimental analysis for this research and our laboratory work in general.
Also I would like to introduce the activity of English classes for graduate school education.

Mr. Arturo Meléndez-Ceballos

Institute de Recherche de Chimie Paris, France

Ph.D. Student at University Pierre et Marie Curie of Paris, and the Institute de Recherche de of Chimie Paris. Graduated with honors from the Master in Environmental Science program of the Mexico State University. Electromechanical engineering title from the Institute of Technology of Toluca. Actually working in research on molten carbonate fuel cells for energy generation and carbon capture and storage, also working on Atomic Layer Deposition of metal oxides in form of thin layers applied to high temperature fuel cells.

"Activities in the field of high temperature fuel cells, in particular MCFCs"

Abstract: High temperature fuel cells (HTFC) as solid oxide fuel cells (SOFC) and molten carbonate fuel cells (MCFC) are electrochemical devices that can produce electricity from a fuel (hydrogen, methane, bio-gas, syngas among others) and oxygen from air by means of an electrochemical reaction that takes place at the cell. The working temperature of this type of cells is in the range of 500 to 1000 °C which allows use of less expensive catalyzers than those used in low temperature fuel cells as proton exchange membrane fuel cell (PEMFC) or direct methanol fuel cell (DMFC), besides that, HTFC have a high efficiency (≈ 50%) and they can reach up to 80% when used in cogeneration with a turbine or for water heating. For all that, these fuel cells constitute a promising technology for clean generation of electricity in the MW scale. Additionally, recent research has shown the viability of carbon dioxide capture and storage using MCFC type cells with important implications in environmental remediation of air and reduction of CO_2 emissions.

Mr. Kyohei Kanki

Department of Chemical Science and Engineering,
Graduate School of Engineering, Kobe University, Japan

Mr. Kyohei KANKI was born in 1992 in Japan. He graduated from the Department of Chemical Science and Engineering, Faculty of Engineering, Kobe University and earned a B. Eng. in March 2014. He entered the Graduate School of Engineering (Master's Course) and carried out his research on carbon capture and storage (CCS) and High Temperature Fuel Cells (HTFCs) for energy generation.He has been awarded a Young Electrochemistry Presentation Award (Kansai branch, The Electrochemical Society of Japan). His research interests are in molten salt, interfacial chemistry, and electrochemistry. His hobbies include baseball and snowboarding.

"CO_2 absorption behavior of ceramics/molten salts composite in high temperature"

Abstract: Lithium Orthosilicate (Li_4SiO_4), a type of ceramic CO_2 absorbent, has a large absorptive capacity (36.7 wt.%) and also has heat resistance. This material has some useful application as a separator in Molten Carbonate Fuel Cell and as a direct CO_2 absorbent in large-scale emission sources, for example, thermal power stations; because the absorption and desorption reaction equilibrium temperature is around 993 K. In this study, we focused on CO_2 absorption behaviors of Li4SiO4 at lower temperatures. It was found that samples whose surface was modified with ball milling method under Ar atmosphere showed a tendency to increase the surface area estimated by BET method measured by N_2-isotherm and increase of Si dangling bond measured by ESR. Also, it was found that there are two different absorption processes, one is a chemisorption at the surface (T<773 K) the other is a bulk diffusion (T>773 K) by the result of TG-DTA. Furthermore, it was found that carbonate coexistence and grinding by ball milling made the activation free energy decrease as seen in the isothermal analysis.

Session 3 [14:30-18:00]

Perspectives on Interdisciplinary Research and Education of Economics and Law

Chair

Prof. Takashi Yanagawa
Interfaculty Initiative in the Social Sciences, Kobe University, Japan

Speakers

Prof. Narufumi Kadomatsu
Graduate School of Law, Kobe University, Japan

Dr. Axel Marx
Leuven Centre for Global Governance Studies, University of Leuven, Belgium

Prof. Hiroshi Takahashi
Graduate School of Law, Kobe University, Japan

Prof. Janina Satzer
Institute of Law and Economics, University of Hamburg, Germany

Kobe University proposes an "Econo-Legal Studies" that combats problems in our society through the dual lenses of economics and law. Collaboration between economics and law is a necessary and effective approach to solving complex social problems. Five panelists discussed the prospects of interdisciplinary research and education in economics and law based on the experience of Econo-Legal Studies at Kobe University, Leuven Centre for Global Governance Studies at KU Leuven, and the Institute of Law and Economics at the University of Hamburg.

First, **Takashi Yanagawa** from Kobe University discussed "Prospects of Interdisciplinary Research of Economics and Law: A View from Economics." **Narufumi Kadomatsu** from Kobe University presented on "Prospects of Interdisciplinary Research of Economics and Law: A View from Law." They explained econo-legal studies from the perspectives of an economist and a legal scholar. Economists and legal scholars at Kobe University previously encountered difficulties in developing joint research, but now they work together effectively in many fields. These speakers analyzed resale-price maintenance and landscape, respectively, as examples of econo-legal studies.

Following this, **Axel Marx** from KU Leuven gave a talk on "Interdisciplinary Research in the Social Sciences: the Case of the Leuven Centre for Global Governance Studies." He showed how to organize interdisciplinary projects for not only economics and law but also political science, history and philosophy. We learned the importance of "openness" and that we can achieve this through joint projects.

Hiroshi Takahashi from Kobe University discussed "Econo-Legal Education: the Experience of Kobe University." And finally, **Janina Satzer** from the University of Hamburg presented on "The European Master in Law & Economics-25 Years of Experience in Interdisciplinary Education and Research." They explained interdisciplinary education in economics and law for undergraduate students at Kobe University and for graduate students at the University of Hamburg. The University of Hamburg has a very interesting and sophisticated program of law and economics that is helpful to refer to when considering the future of the program at Kobe University.

Prof. Takashi Yanagawa chair

Interfaculty Initiative in the Social Sciences, Kobe University, Japan

YANAGAWA Takashi has been a professor in the Graduate School of Economics at Kobe University since 2004 and the Director of Interfaculty Initiative in the Social Sciences at Kobe University since 2014. He received his Ph.D. from the University of North Carolina at Chapel Hill in 1993. He worked at Nagoya Gakuin University from 1992-99, and has been a faculty member at Kobe University since 1999. He was a visiting researcher at the London School of Economics from 1996-97, the University of California at Berkeley from 2004-05, and the Japan Fair Trade Commission from 2008-11. He has been a managing director of the Japan Economic Policy Association since 2010.

"Prospects of Interdisciplinary Research of Economics and Law: A View from Economics"

Abstract: We often find that economists and lawyers do not work together though the economic and social problems are common. We sometimes even find the disagreement between economists and lawyers about the solution to the problems. We need to find the reason of the unconcern and disagreement about cooperating among economists and lawyers. The unconcern and disagreement occur because of the difference in topics of interest, analytical tools, and a way of thinking and evaluating.

Law and economics is the "economic analysis of law."It focuses on the economic efficiency of the law, and one-way approach from economics to law. In contrast to law and economics, "Econo-Legal Studies" is the legal studies incorporating the accumulated heritage of economics for legal scholars, and at the same time, economics incorporating the accumulated heritage of legal studies for economists. We consider that this approach enables both economists and lawyers to solve economic and social problems together, collaboratively, and in a practical and effective way.

We deal with resale price maintenance and show the dispute in major countries. Then, I introduce the recent revision of "Guideline concerning distribution systems and business practices". Finally, we evaluate it from the viewpoint of Econo-Legal studies.

Prof. Narufumi Kadomatsu

Graduate School of Law, Kobe University, Japan

Narufumi Kadomatsu is a Professor of Administrative Law at the Graduate School of Law, Kobe University. After graduating from the University of Tokyo in 1986, he studied at Master's and Doctoral Program at its Graduate School. He also worked as a Research Associate at the University of Tokyo's Institute of Social Science. He was appointed Associate Professor at Kyushu University in 1996 and transferred to Kobe University as a Professor in 2005. He also studied one year at the University of Hamburg (1998-1999) and taught Japanese Law at the University of Munich (2003-2004).

His research mainly focuses on city planning law and land use regulations as well as other fields of administrative law. His English publications are available at http://ssrn.com/author=2238632 and at his website http://www2.kobe-u.ac.jp/~kado/.

"Prospects of Interdisciplinary Research of Economics and Law: A View from Law"

Abstract: "Econo-Legal Studies" is an academic approach that uses dual lenses of legal studies and economics in order to solve economic and social issues by an effective cooperation of lawyers and economists.

In this presentation, I pick up a problem of landscape protection in Japan and how the interdisciplinary dialogue between legal studies and economics can help us in understanding a social problem. I will show that the key concepts in legal studies and economics such as "property", "externality" and "commons" can be more deeply analyzed if we use the dual lenses of legal studies and economics.

Dr. Axel Marx

Leuven Centre for Global Governance Studies, University of Leuven, Belgium

Axel Marx is deputy-director of the Leuven Centre for Global Governance Studies, KU Leuven. He studied in Leuven, Hull and Cambridge and holds a PhD from the KU Leuven. His research mainly focuses on global governance, certification, sustainability standards, non-state market regulation, human rights, trade governance, good governance, international cooperation, international development, research methodology, comparative case methods and qualitative comparative analysis. His international academic publications (over 30) have appeared *inter alia* in European Political Science Review, Regulation and Governance, Political Research Quarterly, Journal of Socio-Economics, Globalizations and Sociological Methodology. He co-edited (with Miet Maertens, Jo Swinnen and Jan Wouters) a book on *Private Standards and Global Governance* (Edward Elgar). Two books are forthcoming with Edward Elgar (November 2015) on *Global Governance Through Trade* and *Global Governance of Labour Rights*.

"Interdisciplinary Research in the Social Sciences: the case of the Leuven Centre for Global Governance Studies (KU Leuven)"

Abstract: The presentation will introduce the Leuven Centre for Global Governance Studies ('The Centre') of KU Leuven as a case study of an interdisciplinary research centre. The Centre was founded in 2007 and was set up to promote, support and carry out high-quality international, innovative and interdisciplinary research on global governance. In addition to its fundamental research activities the Centre carries out independent applied research and offers innovative policy advice and solutions to policy-makers on multilateral governance and global public policy issues. Since 2010, the Centre has been recognized as a KU Leuven Centre of Excellence. The Centre promotes pioneering projects on the intersection between law, economics, political science, history and/or philosophy and actively initiates and encourages interdisciplinary, cross-cutting research initiatives in pursuit of solutions to real world problems. In addition to its fundamental research, GGS carries out independent applied research and advises policy-makers on multilateral governance and global public policy issues. It regularly organizes conferences, seminars and debates on these issues, including a summer school. It works with academic and policy partners from all over the world, including the European Parliament, the European Commission, the European External Action Service, the Committee of the Regions, the OECD, ILO, UNIDO, UNCTAD, the World Bank and the WTO. The Centre currently employs more than 30 full time in-house staff and researchers. The presentation will introduce the genesis of the Centre, its development and its experiences with conducting interdisciplinary research. It will also discuss its overall philosophy towards interdisciplinary research and the challenges involved in conducting interdisciplinary research.

Prof. Hiroshi Takahashi

Graduate School of Law, Kobe University, Japan

Hiroshi TAKAHASHI studied the sociology of law and received a Master's degree in Law from the University of Tokyo. He lectured at Kwansei Gakuin University, and is now a professor at Kobe University Graduate School of Law. His research interests include the sociological analysis of ADR, legal profession and judicial statistics. His publications include: "Career Patterns of Japanese Judges," Choi & Rokumoto (eds.) *Judicial System Transformation in the Globalizing World* (Seoul National University Press, 2007) and "Toward an Understanding of the "Japanese" Way of Dispute Resolution," D. Vanoverbeke / J. Maesschalck / St. Parmentier / D. Nelken (eds.) *The Changing Role of Law in Japan* (Edward Elger, 2014).

"Econo-Legal Education: the Experience of Kobe University"

Abstract: This presentation aims to describe our project, 'Econo-Legal Studies' (ELS), from an educational point of view. 'Econo-legal Studies' is an interdisciplinary attempt to fill the gap between legal perspective and economic perspective so that we can effectively analyze and tackle complex social problems occurring in contemporary world. It is obviously difficult to make undergraduate students acquire such an interdisciplinary way of analysis. To this end, Kobe University offers a unique two-year curriculum taught cooperatively and intensively by lawyers and economists. The presenter will explain some outstanding features of Econo-Legal Education at Kobe as well as the background of the program, and try to discuss the challenges of the future for the ELS program.

Ms. Janina Satzer

Institute of Law and Economics, University of Hamburg, Germany

Head of Programme Coordination of the Institute of Law & Economics (ILE) at University of Hamburg, Germany.
Awarded MSc in Economics from Ruhr-University Bochum, Germany in 2001. After previous research fellow positions with several European universities (Universities of Southern Denmark Esbjerg, Denmark; Marburg and Kassel, Germany) joined the ILE as General Manager in 2011. Responsible for the management of several masters and doctoral programmes (including the "European Master in Law and Economics"), all of them co-funded by national and/or European research funding organisations like EC, DFG, and DAAD). Her research focuses on the law & economics of sports.

"The European Master in Law & Economics —25 Years of Experience in Interdisciplinary Education and Research"

Abstract: This presentation aims to describe the unique educational programme "European Master in Law & Economics (EMLE)" offered by the University of Hamburg as one of partner of the EMLE consortium.
The EMLE is designed to provide students with advanced knowledge in the Economic Analysis of Law. This field of study uses economic methods to explain and assess the effects of law. The EMLE uses a comparative approach to evaluate the strengths and weaknesses of alternative legal rules from an economic perspective. For lawyers, a familiarity with the economic effects of legal rules has become indispensable for law making and for understanding the needs of commercial clients (e.g., law/counselling firms that are active internationally). Similarly, economists will profit from an accurate understanding of the institutional legal framework of market economies. For both, knowledge of the other discipline and international contacts are crucial for a successful career. The EMLE programme is the institutional response to these challenges. After discussing the importance, origin and standing of the discipline "law and economics", the presenter will introduce the programme structure and courses in the EMLE and its significance in preparing students for a professional career.

Session 4 [14:30-18:00]

Recent Advances in In Vitro Modeling of the Human-Microbial Gastrointestinal Interface

Chair

Prof. Ken-ichi Yoshida
Department of Agrobioscience,
Graduate School of Agricultural Science, Kobe University, Japan

Speakers

Prof. Tom Van de Wiele
Laboratory of Microbial Ecology and Technology,
Faculty of Bioscience Engineering, Ghent University, Belgium

Dr. Joëlle Fritz
The Eco-Systems Biology Research Group Luxembourg Centre
for Systems Biomedicine, University of Luxembourg, Luxembourg

Prof. Christophe Lacroix
Institute of Food, Nutrition and Health, ETH Zürich, Switzerland

Prof. Ro Osawa
Graduate School of Agricultural Science, Kobe University, Japan

In vitro modeling of the human-microbial gastrointestinal interface is increasingly recognized as a useful biological tool to help us understand an array of compound and elaborate interactions among the host, its microbiota, and its ingested food ingredients. In this session, four speakers, each representing a distinct study group of four different nationalities, addressed recent advances in their own unique modeling.

In the first talk, **Professor Dr. ir Tom Van de Wiele** from the Faculty of Bioscience Engineering of Ghent University highlighted the current in vitro technological advances in simulating the gut microbiome composition and functionality. These advances were achieved by simulating microbiome of different colon regions, luminal and mucus-associated microbial communities, and the host-microbes interaction near the gut epithelial surface.

Following this, **Doctor Joëlle Fritz** from Luxembourg Centre for Systems Biomedicine of the University of Luxembourg presented her group's microfluidics-based device, HuMiX, which allows co-culture of human and microbial cells under biomimetic conditions and supports investigations of host-microbe molecular interactions.

Professor Dr. Ing. Christophe Lacroix from the Institute of Food, Nutrition and Health, ETH Zürich continued the session with a presentation about his group's development of a novel process of immobilization of fecal microbiota in gel beads mimicking cell density and competition of in vivo gut microbiota. This is known as PolyFermS and can be expanded to various configurations, allowing the comparison of different treatment effects and a control inoculated with the same microbiota.

Finally, **Professor Ro Osawa** from the Research Center for Food Safety and Security of Kobe University discussed his group's novel human intestinal simulation system, called "Kobe University Human Intestinal Model".

After these presentations, all attendees discussed the technologies and applications of their human-microbial gastrointestinal interfaces.

Prof. Ken-ichi Yoshida chair

Department of Agrobioscience,
Graduate School of Agricultural Science, Kobe University, Japan

After a Master obtained at Kyoto University in 1989, he got the position of Assistant professor at Fukuyama University in 1990 and obtained a PhD at Kyoto University in 1993.
After a Post-Doc experience at INRA, France, from 1996 to 97, he moved to Kobe University in 2004 as an Associate Professor, and was promoted to Professor of Applied Microbiology in 2009.
He has specialized in functional genomics of bacteria including Bacillus subtilis and its relatives since the very beginning of his career to date.
He was once awarded the prize for "Encouragement of Young Scientists" (2002) and twice the prize for "Excellent papers" from the Japan Society for Bioscience, Biotechnology, and Agrochemistry (2008 and 2014).
He served in the Research Promotion Bureau in Ministry of Education, Culture, Sports, Science and Technology, Japan (MEXT), as a Program Officer (Scientific Research Senior Specialist) (2005-2007).
Currently he also serves in Kobe University Brussels European Centre as Executive Director since April 2014.

Prof. Dr. ir Tom Van de Wiele

Laboratory of Microbial Ecology and Technology,
Faculty of Bioscience Engineering, Ghent University, Belgium

Professor at the Laboratory of Microbial Ecology and Technology at Ghent University in Belgium. Following his M.Sc. studies in Bioscience Engineering with a major in Environmental Technology, he obtained his PhD in Applied Biological Sciences in 2004, working on the oral bioavailability and gastrointestinal speciation changes of ingested xenobiotics. He was a visiting scholar in 2007 at Ohio State University in Columbus, OH, USA. His primary research interest is the host-associated microbiome with a primary focus on gastrointestinal microbial ecology and technology.

"In vitro models to study the mucosal microenvironment of the human gut"

Abstract: This talk will highlight our current in vitro technological advances in simulating the gut microbiome composition and functionality. While our in vitro models offer the standard advantages over in vivo studies (low costs, no ethical constraints, multi-parametric testing), their core value lies in their ability to simulate regional and micro-environmental
differences that occur along the longitudinal and radial axis of the gut. We will evidence how these models can be used (1) to simulate microbiome differences between proximal and distal colon regions, (2) to establish distinct luminal and mucus-associated microbial communities, and (3) to enable intimate host-microbe interactions near the gut epithelial surface. More specifically, we will present published and unpublished data obtained with the Mucosal Simulator of the Human Intestinal Microbial Ecosystem (M-SHIME), the Host-Microbe Interaction (HMI-) module and the 3-D model of the colon epithelium obtained in the Rotating Wall Vessel (RWV) bioreactor. Finally, our insights into the specific micro-environmental behaviour of gut microbes will be used to propose 4 future perspectives for (in vitro) gut microbiome research.

Dr. Joëlle Fritz

The Eco-Systems Biology Research Group, Luxembourg Centre
for Systems Biomedicine, University of Luxembourg, Luxembourg

Sep. 2012- until now : Senior research associate at the Luxembourg Centre for Systems Biomedicine, Luxembourg in the group headed by Prof. Paul Wilmes. Topic: human host-microbes interaction, special focus on human gut microbiome and host responses.
Nov. 2009- July 2012 : Post-doc fellow at the University Hospital Heidelberg, Germany; Working group headed by Prof. Oliver Fackler; Topic: Interplay between HIV-1 Vpu protein and the human host response during HIV-1 infection.
Oct. 2005- Aug. 2009 : PhD student at the University of Strasbourg, France; Working group headed by Prof. Yves Mély; Topic: The role of HIV-1 Vpr protein in viral assembly and functionality.

"A microfluidics-based in vitro model of the gastrointestinal human-microbe interface"

Abstract: Changes in the human gastrointestinal microbiome are associated with several idiopathic diseases. To infer causality, experiments in representative models are essential. Widely used animal models exhibit limitations and the development of new experimental systems presents a challenge. Here we present a microfluidics-based device, HuMiX, which allows co-culture of human and microbial cells under biomimetic conditions. We demonstrate the ability of the model to recapitulate transcriptional, metabolic and immunological responses of human intestinal epithelial cells following their co-culture with commensal *Lactobacillus rhamnosus* GG. More specifically, we show that human cells exhibit a concordant expression of genes involved in immune responses and epithelial barrier function when compared with mammalian mucosal in vivo data. We identify uncharacterized human small RNAs which are differentially expressed following co-culture as well as changes in metabolic transformations linked to the urea cycle and GABA. HuMiX supports investigations of host-microbe molecular interactions and awaits its application to a range of fundamental research questions linking the gastrointestinal microbiome to human health and disease.

Prof. Dr. Ing. Christophe Lacroix

Institute of Food, Nutrition and Health, ETH Zürich, Switzerland

Christophe Lacroix is Professor for Food Biotechnology, Department of Health Science and Technology, ETH Zürich, after being Professor of Dairy Biotechnology for 18 years at the Université Laval, Quebec, Canada. His main research interests include the fundamental and technological characterization of functional microbes and their roles in food and intestinal ecosystems, with multidisciplinary system-oriented aspects. This includes ecosystem study and microbe screening and characterization, functional studies and mechanisms, microbial technology, and intestinal research (from in vitro modeling to in vivo human studies). He has published more than 260 articles in scientific peer-reviewed journals, and supervised 48 doctoral students.

"PolyFermS, a flexible intestinal fermentation platform to investigate monogastric gut microbiota"

Abstract: A complex relationship occurs in the intestine between the gut microbiota, diet, and host. Different in vitro and in vivo strategies have been applied to elucidate mechanisms or functions of dietary compounds on the gut microbiota, health, and physiology of human. Recent research has shown the potential of combining in vitro models and in vivo investigations within a coherent strategy. In most models it is difficult to reproduce both the planktonic (free-cell) and sessile (biofilm-associated) bacterial populations in the colon. A rapid washout of less competitive or slow growing bacteria occurs during continuous fermentation, decreasing the experimental time. We developed a process of immobilization of fecal microbiota in gel beads mimicking cell density and competition of in vivo gut microbiota. Novel models, based on the new PolyFermS platform, using immobilized fecal microbiota, were recently validated with immobilized human and swine gut microbiota. These models are composed of a first-stage inoculum reactor seeded with immobilized fecal microbiota and used to constantly inoculate (5–10%) parallel operated systems, set to mimic different colon sections. PolyFermS models can be expanded to various configurations, allowing the comparison of different treatment effects and a control inoculated with the same microbiota. This model has been tested for periods up to 100 days, and is suited for parallel screening and mechanistic investigations of gut microbiota factors.

Prof. Ro Osawa

Graduate School of Agricultural Science, Kobe University, Japan

Professor in the Graduate School of Agricultural Science, Kobe University. He graduated from the Veterinary School of Hokkaido University, Japan, and obtained a Ph.D degree in the field of veterinary medicine from the University of Queensland, Australia as well as another Ph.D degree in the field of agricultural science from Tohoku University, Japan. His current research interests include development of technologies to ensure "traceability" of pathogenic bacteria endangering safety of foods and agricultural products in the course of "from stable to table" and development of safe and effective probiotics to promote health of both human and animals.

"An introduction to Kobe University Human Intestinal Model (KUHIM)"

Abstract: The conventional approach to testing the efficacy and safety of functional food components is to start with tissue-culture based in vitro studies. This is then followed by experimental animal based in vivo studies, and finally human intervention trials. However, many food components are difficult to assess, especially in the human intervention studies for the following reasons:

1) Some components are too big in molecular size to pass through the human intestinal wall to reach their target organs or cells.

2) Transition time of the digesta and microbiota in the intestine of the experimental animals is quite different from that of humans.

In order to overcome these problems, we have developed a novel human intestinal simulation system, called "Kobe University Human Intestinal Model", which consists of 1) bi-phasic tissue culture system that simulates human intestinal immune system and 2) continual anaerobic culturing system that simulates an obligate anaerobe dominant microbiota of human large intestine together with its diversity (inclusive of "unculturable" bacteria) and its short chain fatty acid production pattern. KUHIM is now successfully being used to evaluate functionality and safety of both conventional and potential prebiotics, probiotics, and biogenics. Some examples of the research being carried out in Japan, using this model system, will be presented.

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1-1,Rokkodai-cho, Nada-ku, Kobe, 657-8501 Japan
E-mail: intl-relations@office.kobe-u.ac.jp