iCeMS*Focus* Kyoto University iCeMS © 2012

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The WPI program was founded in 2007 at the initiative of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) with the aim of establishing and operating a network of world-class scientific research centers.

Kyoto University's iCeMS is one of six institutes in this program.

For details see www.jsps.go.jp/english/e-toplevel/

iCeMS*Focus*
Institute for Integrated Cell-Material Sciences, Kyoto University

RSC Launches *Biomaterials Science* in Collaboration with Kyoto University iCeMS

New Royal Society of Chemistry journal aims to "bring together the molecular and mesoscopic interactions of biomaterials and their potential applications."

Academic and industrial researchers in the field of biomaterials have a new option for the publication of their research in 2012, with the launch of the latest Royal Society of Chemistry journal *Biomaterials Science*.

The journal is a collaborative venture between RSC Publishing and Kyoto University's Institute for Integrated Cell-Material Sciences (WPI-iCeMS). The new journal bridges material science, biology, chemistry and physics and will ensure through free access the authors' work has maximum visibility.

Announcing the launch, James Milne, acting Managing Director of Publishing at the RSC, said: "We are delighted to support the biomaterials research community with this new journal, and are looking forward to collaborating closely with the iCeMS. Together we are confident we can establish a new world class journal for the biomaterials sciences, providing authors in this rapidly growing field with a journal characterised by the quality, speed of publication and innovative technology for which RSC Publishing is renowned.

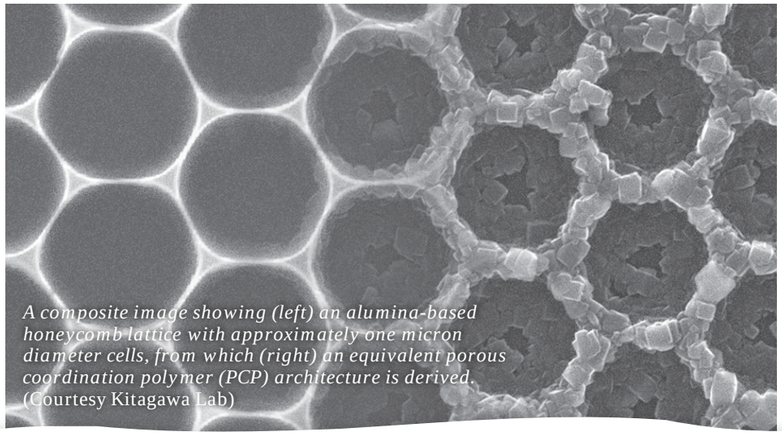
continues on page 3...

contents

Faster, Cheaper Gas and Liquid Separation Using Custom Designed and Built Mesoscopic Structures

iCeMS researchers describe their new "reverse fossilization" manufacturing process in a *Nature Materials* paper.

continues on page 2...



A composite image showing (left) an alumina-based honeycomb lattice with approximately one micron diameter cells, from which (right) an equivalent porous coordination polymer (PCP) architecture is derived. (Courtesy Kitagawa Lab)

"Reverse Fossilization" *...continued from page 1*

In what may prove to be a significant boon for industry, separating mixtures of liquids or gasses has just become considerably easier.

Using a new process they describe as "reverse fossilization," scientists at Kyoto University's WPI Institute for Integrated Cell-Material Sciences (iCeMS) have succeeded in creating custom designed porous substances capable of low cost, high efficiency separation.

The process takes place in the mesoscopic realm, between the nano- and the macroscopic, beginning with the creation of a shaped mineral template, in this case using alumina, or aluminum oxide. This is then transformed into an equivalently shaped lattice consisting entirely of porous coordination polymer (PCP) crystals, which are themselves hybrid assemblies of organic and mineral elements.

"After creating the alumina lattice," explains team leader Assoc Prof Shuhei Furukawa, "we transformed it, molecule for molecule, from a metal structure into a largely non-metallic one. Hence the term 'reverse fossilization,' taking something inorganic and making it organic, all while preserving its shape and form."

After succeeding in creating both 2-dimensional and 3-dimensional test architectures using this technique, the researchers proceeded to replicate an alumina aerogel with a highly open, sponge-like macro-structure, in order to test its utility in separating water and ethanol.

"Water/ethanol separation has not been commonly possible using existing porous materials," elaborates Asst Prof Julien Reboul. "The PCP-based structures we created, however, combine the intrinsic nano-level adsorptive properties of the PCPs themselves with the meso- and macroscopic properties of the template aerogels, greatly increasing separation efficiency and capacity."

Lab head and iCeMS Deputy Director Prof Susumu Kitagawa sees the team's achievement as a significant advance. "To date, PCPs have been shown on their own to possess highly useful properties including storage, catalysis, and sensing, but the very utility of the size of their nanoscale pores has limited their applicability to high throughput industrial processes. Using reverse fossilization to create architectures including larger, mesoscale pores now allows us to begin considering the design of such applications."

Additional details (including media coverage information) are available on the iCeMS website. ■

Team members (from left) Assoc Prof Furukawa, Prof Kitagawa, and Asst Prof Reboul announcing their findings at a press conference.

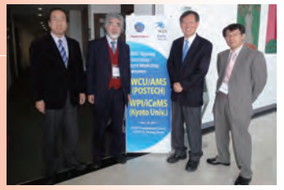
photo © iCeMS 2012

Mesoscopic architectures of porous coordination polymers fabricated by pseudomorphic replication by Julien Reboul, Shuhei Furukawa, Nao Horike, Manuel Tsotsalas, Kenji Hirai, Hiromitsu Uehara, Mio Kondo, Nicolas Louvain, Osami Sakata, and Susumu Kitagawa. *Nature Materials* **11**, 717–723 (2012). Doi 10.1038/nmat3359.

"The authors thank N Morone, the support from CeMI, and T Tsuruoka for assistance with measurement for FESEM, and K Shiomi for assistance with breakthrough experiments. iCeMS is supported by World Premier International Research Initiative, MEXT, Japan."

Notable Updates and Recent Publications

Recent international meetings



right: MoU signing ceremony in Seoul with the Division of Advanced Materials Science, Pohang University of Science and Technology (POSTECH AMS), November 2011

Joint symposium at Peking University (*left*) and Tsinghua University (*right*) in April 2012 marking the signing of an MoU with the Center for Life Sciences (CLS).

photos © iCeMS 2012

Notable recent publications

A DNA-based molecular motor that can navigate a network of tracks | Shelley F J Wickham, Jonathan Bath, Yousuke Katsuda, Masayuki Endo, Kumi Hidaka, Hiroshi Sugiyama, and Andrew J Turberfield | *Nature Nanotechnology* | doi **10.1038/NNano.2011.253** | January 22, 2012

Coordination-network-based Ionic Plastic Crystal for Anhydrous Proton Conductivity | Satoshi Horike, Daiki Umeyama, Munehiro Inukai, Tomoya Itakura, and Susumu Kitagawa | *Journal of the American Chemical Society* | doi **10.1021/ja301875x** | April 18, 2012

Amyotrophic lateral sclerosis model derived from human embryonic stem cells overexpressing mutant superoxide dismutase 1 | Tamaki Wada, Sravan K. Goparaju, Norie Tooi, Haruhisa Inoue, Ryosuke Takahashi, Norio Nakatsuji, and Kazuhiro Aiba | *Stem Cells Translational Medicine* | doi **10.5966/sctm.2011-0061** | May 8, 2012

Transient GPI-anchored protein homodimers are units for raft organization and function | Kenichi G N Suzuki, Rinshi S Kasai, Koichiro M Hirosawa, Yuri L Nemoto, Munenori Ishibashi, Yoshihiro Miwa, Takahiro K Fujiwara, and Akihiro Kusumi | *Nature Chemical Biology* | doi **10.1038/nchembio.1028** | July 22, 2012

Upcoming conferences

6th Annual Symposium on Nanobiotechnology: "**Kyoto Cell-Material Integration 2012**"
November 8–9, 2012 / Kyoto Univ Shiran Kaikan

One-Day Symposium: "**Artificial Photosynthesis & Solar Energy Conversion**"
November 20, 2012 / Kyoto Univ Shiran Kaikan

(see the iCeMS website www.icems.kyoto-u.ac.jp for details)

"Sugiyama interview" *...continued from page 4*

As the name indicates, students first need to be studious to evolve as the next generation of scientists. They should not only work hard but also smart and design experiments in a systematic manner. It is possible that they may face some troubles during the course of their experiments. Instead of giving up, they should think hard and profoundly consider all possibilities from various angles to shoot those troubles off. I personally believe that constructive discussions with the fellow colleagues even if they don't belong to the same discipline can mutually complement each other`s research.

If you weren't a scientist, what would you be?

During the course of my research career, several times I came across this question. Every time I find this question as a difficult one to answer. Science has always fascinated me more than any other field and I really enjoy being a scientist. So I could not contemplate any other probability. ■

"Heidelberg-Kyoto partnership" *...continued from page 5*

University, Göttingen University, and Osaka University (whose names together spell "HeKKSaGOn"), plan to accelerate collaboration in research and teaching, initiate joint research projects as well as graduate programs, and enhance support for the exchange of students, doctoral candidates, and other scholars.

The conference surrounding the signing of this 2010 agreement, hosted by Heidelberg University and funded by the Robert Bosch Foundation, set the stage for the participants to engage in extensive discussions related to fields of study of particular strength at each institution. One of the seven section meetings convened during the conference, entitled "Life Science Meets Natural Science: Crossing Borders", was initiated and organized by Motomu Tanaka, professor of physical chemistry at the University of Heidelberg, who introduced and brought together the directors of two key centers at Heidelberg and Kyoto: Heidelberg University Collaborative Research Center SFB 873's (Sonderforschungsbereich 873) Anthony D Ho, and Kyoto University Institute for Integrated Cell-Material Sciences' (WPI-iCeMS) Norio Nakatsuji.

These two centers have since become a driving force behind joint Heidelberg-Kyoto efforts. In November 2010, the WPI-iCeMS hosted a seminar, entitled "Stem Cell Research Center of Heidelberg: Basic and Multidisciplinary Research to Medical Applications", including SFB 873 Profs Ho, Tanaka, and Thomas W Holstein. Later that month, Heidelberg University invited Prof Nakatsuji as a speaker at a three-day symposium, "Stem Cell Research: Opportunities and Risks", held together with the University of California, San Diego.

Then in July 2011, SFB 873 and WPI-iCeMS jointly organized a three-day conference in Heidelberg, significantly advancing truly multi-disciplinary collaboration between the two universities and demonstrating their leading role in the growing field of cell-material integration. The symposium – "Crossing Boundaries: Stem Cells, Materials, and Mesoscopic Sciences", held at the German Cancer Research Center (DKFZ) – brought together not only the highest caliber stem cell scientists from across the globe, but also chemists, physicists, and cell biologists, including keynote speakers Austin Smith, director of the University of Cambridge Wellcome Trust Centre for Stem Cell Research, and Institut Curie Professor Françoise Brochard-Wyart. The conference's wide array of speakers provided numerous novel insights, engaging in vibrant discussions with each other and with the diverse audience of 300 attendees representing scientific institutions, government bodies, biotechnology companies, and academic publishers (see also this issue's editorial by Profs Ho and Nakatsuji for further details on the meeting).

Maintaining this momentum, the HeKKSaGOn consortium held its second conference in March 2012, focusing on strategy deliberations among the universities' senior administrators. The two-day conference, hosted by Kyoto University and funded by the Japan Society for the Promotion of Science (JSPS) and the Robert Bosch Foundation, also covered a broad range of research topics, including environmental sciences, cultural studies, and robotics technology. Profs Ho and Nakatsuji coordinated a colloquium on the fusion of the life and materials sciences, inviting distinguished researchers in the field from within the six-university framework: Holstein and Tanaka of Heidelberg, Kenichi Yoshikawa of Kyoto, Martin Bastmeyer and Doris Wedlich of KIT, Kensaku Mizuno and Masatsugu Shimomura of Tohoku University, and Toshio Yanagida of Osaka University.

Cooperation at multiple levels is set to continue at a healthy pace, including a summer school for PhD students to be held in 2012 in Heidelberg. Additionally, the next six-university conference is scheduled to take place in September 2013 at Göttingen University. ■

Prof Nakatsuji (left) leading German university consortium members on a tour of the iCeMS Main Building, March 2012.

photo © iCeMS 2012

RSC headquarters in London.

photo © RSC 2012

***"Biomaterials Science* launches"** *...continued from page 1*

"By providing authors with exceptional service through the submission and publication process, and with the excellent editorial team we have involved, we anticipate *Biomaterials Science* will quickly become a preeminent journal in the field."

Biomaterials Science will be a multidisciplinary journal covering the fundamental science of biomaterials and their biomedical applications. The journal opened for submissions in March 2012, and advance articles will be available from August 2012. The first issue will be published in 2013.

Authors submitting to Biomaterials Science will benefit from rapid peer review and publication with no page charges. Authors have the option of publishing their research as an Accepted Manuscript; Open Access publication is also available as an option through RSC Open Science.

Published research will have very high visibility: from launch until December 2014, all content will be freely available online for readers via the website.

Norio Nakatsuji, Professor and Director at Kyoto University's WPI-iCeMS, has been appointed Co-Editor-in-Chief of the new journal. He said at the launch: "It is my great honour and pleasure to work with the Royal Society of Chemistry on the launch of this new cross-disciplinary journal integrating materials science with the cellular and biomedical sciences. Our iCeMS aims to fuse these fields, focusing on stem cells and mesoscopic investigations of living systems and functional materials. The launch of this new journal is therefore an important event for our institute, as with it we seek to present a global platform for fundamental research as well as varied applications of this rapidly expanding field created at the crossing point of biology, chemistry, and physics."

Professor Phillip Messersmith from Northwestern University, USA, also Co-Editor-in-Chief, said: "It is an exhilarating time for the biomaterials research community, as it is enjoying rapid growth, making exciting fundamental discoveries, and driving the development of novel life-saving and life-enhancing therapeutic materials and devices. I look forward to helping shape Biomaterials Science into one of leading journals in the field." ■

RSC | Advancing the Chemical Sciences

The Royal Society of Chemistry is the UK Professional Body for chemical scientists and an international Learned Society for the chemical sciences with more than 47,500 members worldwide. It is a major international publisher of chemical information, supports the teaching of chemical sciences at all levels and is a leader in bringing science to the public.

Call for Papers: Biomimetic Materials

Biomaterials Science invites you to submit your next high impact article on "Biomimetic Materials" to the journal. Publishing only very high quality articles, the journal will cover the fundamental science of biomaterials though to their biomedical applications, including "biomimetic materials."

Articles will be free to access until the end of 2014 giving your article the widest possible audience. We encourage you to support *Biomaterials Science* and not-for-profit publishing by contributing to the journal. You can find our online submission system at mc.manuscriptcentral.com/bmsci and the main journal site at www.rsc.org/biomaterialsscience.

Interview with Hiroshi Sugiyama

Assoc Ed of *Biomaterials Science* speaks with the RSC's Russell Johnson.

What led you to specialise in biomaterials?

For the past 25 years, I have been exploring the nucleic acids using organic chemistry, biochemistry and computational chemistry. The ability of DNA to weave together and bind other molecules, which allow it to act as a scaffold for complex Nano machinery, has always fascinated me. Recent progress in DNA origami further motivated me to employ DNA as a construction material for the supra-molecular "bottom-up" engineering in nano-sciences.

What projects are you working on at the moment?

My research is centered on the chemical biology of nucleic acids and integrates DNA nanotechnology and creation of artificial genetic switch. Nano- technology group uses DNA origami techniques to build nano- and meso-sized structures to acquire vital mechanistic knowledge that could be exploited in gene regulation.

We are also developing sequence-specific DNA binding Pyrrole-Imidazole polyamides as artificial genetic "ON" and "OFF" switch. Based on our recent promising results we are establishing a novel chemical approach to selectively and epigenetically induce pluripotency in somatic cells with our designed molecules.

What do you think are the most important developments in the field of biomaterials at the moment?

In my opinion, clinical translation of the biomaterials is the most important development in this field. Several biomaterials that are compatible with the body are currently used as the implants and replacements of damaged body parts. However, we still have lots of lessons to learn from the microstructural features and designs found in nature. By mimicking the natural environment, we could construct mechanically superior biomaterials. For example, natural transcription factors could precisely modulate the extremely complex gene network and trigger signal transduction at the right place and the right time. It is important that artificial transcriptional activators should retain the capacity of their natural counterparts. I hope that the focus on biomaterials could gain the attention of the multi-disciplinary researchers and encourage them to improve the clinical utility of iPS cells by taking cue from the nature.

Prof Sugiyama (right) together with Managing Editor Liz A Davies and Prof Nakatsuji, preparing to cut a commemorative cake at a journal launch event in Kyoto, January 2012. (photo © iCeMS 2012)

You're one of the Associate Editors for *Biomaterials Science*. What excites you most about your new role?

In my opinion, science should not be confined within certain disciplines. It is high time that we cross the boundaries, which has been limiting our creative capacity. By integrating fragmented disciplines, we could mobilize the intellectual resources to overcome our limitations. The history of greatest scientific achievements like the Newton's apple story or Kekulé structure have taught us that the idea behind those and most other countless creative discoveries were triggered by the most unlikely everyday incidents. I am excited because I will be part of the team that will lead the science in a new direction without self-restricted boundaries. We hope to unleash the creativity of the scientists with this inter-disciplinary journal.

As science becomes increasingly interdisciplinary, how do you see the future of science, and in particular biomaterials science, developing?

I would like to give this quote "It is not enough to do our best, we first need to know what to do and then give our best." Accordingly we should have a clear idea of the goal we intend to solve and/or achieve. It is possible that some researchers work on different disciplines with diverse strategy but their scientific goal may be common to other researchers who belong to an unrelated discipline. We need to have a comprehensive view of the given problem and need to be aware of the area where we may lack expertise but which is essential to achieve our goal. Synergistic efforts of the scientists from different disciplines who share their knowledge base with productive discussions could accelerate our progress towards a given goal. In this regard, development of biomaterials science provides an ideal platform by integrating diverse scientists who are engineers, cell biologists, material experts and clinical physicians.

What advice would you give to the students who will be the next generation of scientists?

continues on page 7...

Heidelberg-Kyoto Symposium Featured in Special Issue of *Biotechnology Journal*

Groundbreaking papers form core of "Stem Cells and Materials."

Scientific publisher WILEY-VCH Verlag GmbH & Co in early June released a special issue of its *Biotechnology Journal* entitled Stem Cells and Materials (*Biotechnol J* **7**, 693–823; 2012), featuring the highlights of a conference jointly organized by Kyoto University's Institute for Integrated Cell-Material Sciences (WPI-iCeMS) and the Collaborative Research Center SFB 873 (Sonderforschungsbereich 873) of the University of Heidelberg.

The Heidelberg-Kyoto multidisciplinary symposium — Crossing Boundaries: Stem Cells, Materials, and Mesoscopic Sciences — was held over three days in July 2011, featuring 33 leading researchers in cell biology and material science as speakers. The journal special issue is comprised of 11 review articles based on presentations given by five speakers from the University of Heidelberg and six from Kyoto University, including Senior Lecturer Keisuke Okita of Kyoto University's Center for iPS Cell Research and Application (CiRA).

The directors of the two institutes, Profs Norio Nakatsuji of iCeMS and Anthony D Ho of SFB 873, coauthored an editorial as well as participated in selection of the articles as visiting editors-in-chief.

Prof Nakatsuji is highly pleased with the result. "I am delighted to see that the outcome of such a successful joint symposium has been preserved in the special issue of an international science journal, as well as in the participants' collective memory," he said, following release of the publication. "I find it significant that the featured peer-reviewed papers are written not only by senior researchers but also by many promising younger scientists. With the academic world becoming more and more international and cross-disciplinary, one of the primary aims of such exchanges should be to broaden the sphere of young researchers' activities. In this context, we're always willing to contribute, for the sake of science and technology advancement, to strengthening the Heidelberg-Kyoto partnership and ultimately the friendship between Germany and Japan."

Cover art for the special issue was adapted from the symposium poster created by David H Kornhauser of iCeMS' International Public Relations, depicting Heidelberg Castle and the pagoda at Toji in Kyoto, joined by an electron microscope image of the mesoscopic structures in a cell membrane, provided by iCeMS Prof John Heuser. ■

Heidelberg-Kyoto Partnership Bridges Life and Materials Sciences, Strengthens Ties

Relationship at the core of a bilateral, six-university consortium.

Coinciding with the 150th anniversary of German-Japanese friendship, Kyoto University and Heidelberg University, two universities replete with history and tradition strengthened their close ties at a joint meeting in Heidelberg in July 2011, forming the core of a broad collaborative effort between the two countries.

Cordial relations between the universities of Heidelberg and Kyoto can be traced back over two decades to 1990, when the two signed a memorandum of understanding (MoU) to enhance academic and cultural exchange.

As an illustration of their maturing relationship, in July 2010 the universities of Heidelberg and Kyoto joined with four other leading Japanese and German universities, and their representatives signed an agreement forming the "German-Japanese University Consortium HeKKSaGOn". The six consortium members, Heidelberg, Kyoto, Karlsruhe Institute of Technology (KIT), Sendai-based Tohoku

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