ICC-IMR News

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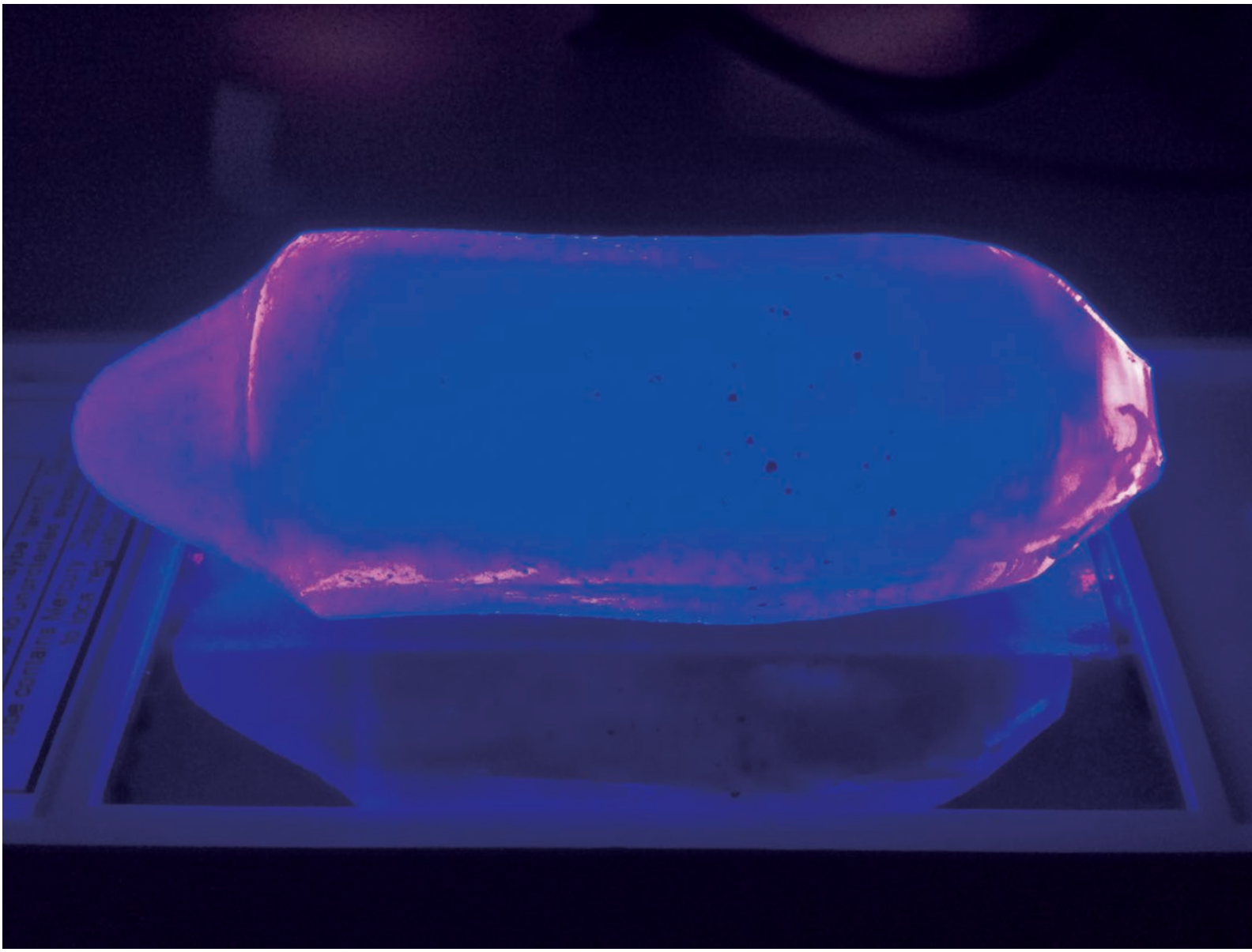


International Collaboration Center
Institute for Materials Research
Tohoku University
ICC-IMR

http://www.icc-imr.tohoku.ac.jp/

ICC-IMR Activities in FY 2017

Visiting Professors

Yongmin KIM,
Dankook University, Korea
May 1-July 31, 2017

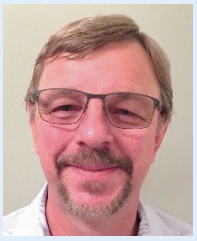
"Transport and Tunneling Properties of 2D Van der Waals Heterostructures" (Host: Nojiri, IMR)

Weerapong CHEWPRADITKUL,
King Mongkut's University of Technology Thonburi, Thailand
June 5-July 8, 2017

"Luminescence and Scintillation Properties of $(Lu_xGd_{3-x})(Al_{2.4}Ga_{2.6})O_{12}$:Ce, x = 0.2,0.4,0.6,0.8 Multicomponent Garnet Crystals" (Host: Yoshikawa, IMR)

Jianfeng ZHANG,
Hohai University, China
Oct. 2-Dec. 31, 2017

"Precipitation of SiC on Superhard Diamond Particles and its Spark Plasma Sintering Combined with WC" (Host: Goto, IMR)



Zlatko SITAR,
North Carolina State University, USA
Jan. 9-March 31, 2018

"The Metalorganic Vapor Phase Epitaxial Growth of InGaAlN" (Host: Matsuoka, IMR)

Research Project

Developments of RE123 Insert Magnet (FY2016–2017)
PI: X. Chaud, LNCMI-CNRS and S. Awaji, IMR

Investigation of Structure and Properties of Nanoporous Metals Formed by Dealloying in Metallic Melt (FY2016–2017)
PI: E. Maire, INSA Lyon and H. Kato, IMR

International Workshop

12th International Workshop on Biomaterials in Interface Science, Aug. 4-5, 2017
Organizer: H. Kato, IMR

14th Materials Science School for Young Scientists (KINKEN-WAKATE 2017), "New Frontier of Molecular Materials NFMM)", Sep. 29-30, 2017
Organizer: T. Sasaki, IMR

International Workshop on New Excitations in Spintronics, Jan. 10-14, 2018
Organizer: G. Bauer, IMR

International Workshop on Ceramic Science and Engineering in Sendai (IWCSE Sendai), March 12-14, 2018
Organizer: T. Goto, IMR

KIST-IMR, Tohoku University Joint Symposium –Advanced Materials and Devices-, Nov. 21-22, 2017
Organizer: E. Saitoh, IMR

ICC-IMR Director
Gerrit E. W. BAUER

Welcome to the ICC-IMR

A famous Japanese saying goes as 富士山に一度も登らぬ馬鹿に二度登る馬鹿 [A fool, who has not climbed Mt. Fuji. A fool, who did it twice.] So what am I, having done it last weekend for the third time? Now, the number of international tourists on Mt. Fuji was astounding, outnumbering the Japanese. Many nationalities were visibly represented (the Dutch also audibly). However, on the summit, everyone shared a collective feeling of accomplishment, irrespective of race, sex, or nationality. In many respects, this is what we hope to achieve with the International Collaboration Center (ICC).

The ICC was founded by the Institute for Materials Research (IMR) of Tohoku University in April 2008. We have been charged to foster top research by facilitating open exchange of ideas and results between the IMR and rest of the world. We welcome applications for joint activities between IMR and overseas researchers, sponsoring junior and senior scientists in the form of integrated projects, guest professorships and shorter research visits, as well as support international workshops and schools. Any of these activities may be initiated by international scientists who seek collaboration with IMR faculty members. With advice from external referees the ICC-IMR Steering Committee prioritizes applications three times per year, based on quality and expected impact of the proposal.

In this ICC-IMR News Bulletin we present a concise summary of activities and exciting results that emerged from the collaborations supported by the ICC-IMR in the past year. We hope that this report will stimulate many new research results as well as mutual international friendship and understanding.

Highlight of ICC-IMR International Workshop

KINKEN-WAKATE 2017: New Frontier of Molecular Materials (NFMM), Sep. 29-30, 2017, Chair T. Sasaki (IMR), Co-chairs S. Iguchi (IMR), J. Müller (Goethe Univ.), B. Powell (Univ. of Queensland), F. Kagawa (RIKEN), H. Seo (RIKEN), S.M. Winter (Goethe Univ.)

New Frontier of Molecular Materials (NFMM) was held as KINKEN-WAKATE of the fiscal year after one of the major international conferences on organic metals, ISCOM 2017. The purpose of NFMM is to cultivate young researchers and develop seeds for new collaborative studies by giving a chance of oral presentations to young researchers and to further stimulate this research field by providing an opportunity for young and senior researchers to communicate with each other. This workshop focuses on almost all the fields in the molecular material science; phase transitions and its control, charge frustrations and its slow dynamics, exotic phenomena such as ferroelectricity, superconductivity, and Dirac electrons, and electronic correlations including π-d and spin-orbit interactions.

Starting with the historical talk about IMR and KINKEN-WAKATE by Prof. H. Fukuyama, 26 oral and 15 poster presentations were made. More than 90% of the oral presentations were made by students and young researchers, which promoted active and fruitful discussions. As well as providing an opportunity of presentation, tutorial lectures were planned for young researchers to promote the deep understanding about the molecular materials science, where physics, chemistry, and theory are the three pillars of the research fields. Thus, three prominent professors, Prof. M. Dressel (physics: optical investigations on organic conductors), Prof. H. Mori (chemistry: hydrogen-related functional molecular materials), and Prof. V. Dobrosavlijevic (theory: geometrically frustrated coulomb systems) were invited for the tutorial lectures. Prof. B. Powell provided the summarized talk of NFMM. With closing remarks by Prof. J. Müller, the conference ended successfully.

The total number of participants were 61, including 18 foreigners from 9 countries. (23 students, 19 young and 11 senior researchers, and 8 professors)

Comments from Visitors

Jianfeng Zhang, Hohai University (China)
2017.10.01-2018.01.01

Research Proposal:
Precipitation of SiC on superhard diamond particles and its spark plasma sintering combined with WC based on cutting tools

My three-months' stay in Sendai was impressive as a visiting scholar supported by the ICC-MIR (International Collaboration Center Institute for Materials Research). Again here, the feeling of familiarity with everything came into my heart since I have ever worked in IMR of Tohoku University for about 6 years from 2008 to 2014. Team members, laboratory apparatus and facility of ICC-MIR accompanied me through a long period of scientific exploration. So I really appreciate the opportunity given to return back, and many thanks to the long history of collaboration with Prof. Takashi Goto as well as his team members.
This time, my project focused on coating highly-active and dispersive SiC nanoparticle layer on diamond by rotary CVD (RCVD), and successful research results were achieved. SiC coated diamond was mixed with WC for spark plasmas sintering, after which the phase diagram change of diamond, the sinterability and the mechanical properties were characterized. Owing to the coated SiC nanoparticles, the phase transformation temperature of diamond went higher from 1873 K to 1973K, and the hardness/ fracture toughness of WC-diamond/SiC composites was further improved effectively.
During my stay, I was also so lucky to view the "Sendai Light Pageant" , a beautiful light celebration of Japanese culture, looking like the stars shining on the trees. It brings me back to old days I have stayed in Sendai.

Jonathan Hughes,
University of Manchester
2017.7.17~2017.9.2

Research Proposal:
Early Stage Precipitate Formation in Cu-based Alloys for Nuclear Fusion Reactors

Thanks to the IMR visiting program, my 7 weeks in Oarai provided me with a crucial and rewarding opportunity to enhance my research and build collaborative ties. The primary focus of my project was to carry out positron annihilation spectroscopy on multiple Cu1.0Cr0.1Zr and Cu1.0Cr alloy samples aged to for different lengths of time. The aims of this are two-fold. Firstly, this aids in characterizing the evolution of nanoscale Cr-rich precipitates within the matrix of these alloys. Secondly, the comparison of the CuCrZr and CuCr alloys allows us to characterize the role of zirconium in the ageing process. Being new to the technique, I found the guidance of Prof. Takeshi Toyama and others in Oarai to be invaluable in successfully carrying out my experiments. My visit has since led to further collaborative efforts on the same project which should, with support from other characterization techniques carried out at the University of Manchester, yield results for publication some time in the coming year. From a personal perspective, having never visited Japan before, this was also an extraordinary opportunity to immerse myself in the Japanese culture.

Despite only visiting for a relatively short period, the benefits of my time in Oarai cannot be overstated in terms of the expansion of both my professional and personal horizons.

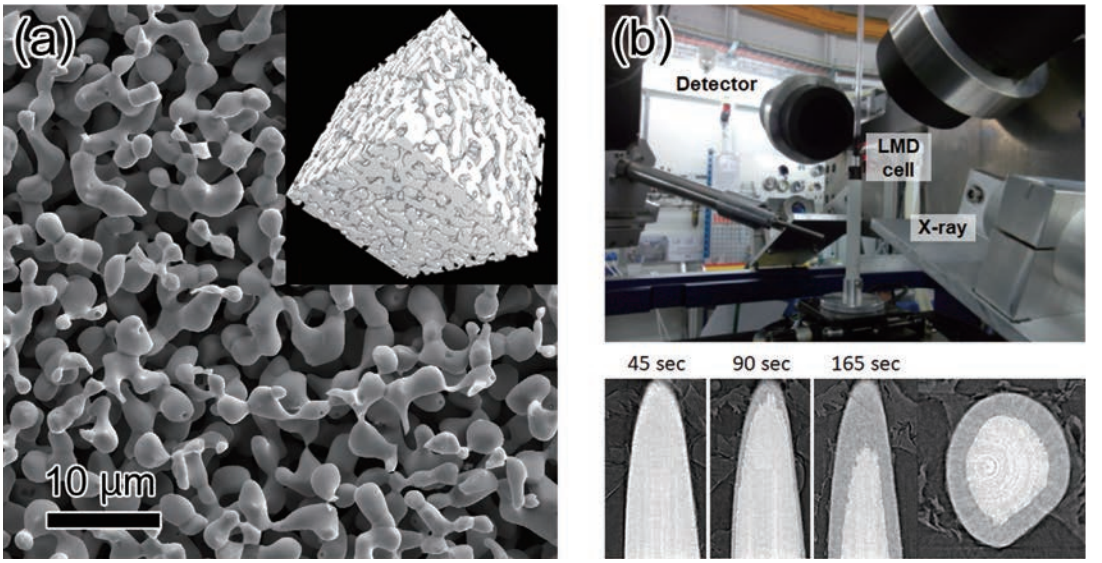
Investigation of Sructure and Properties of Nanoporous Metals Formed by Dealloying in Metallic Melt (FY2016-2017)

PI: E. Maire (Institut National des Sciences Appliquées de Lyon) and H.Kato (Non-Equilibrium Materials Div., IMR)

Nanoporous metals have attracted considerable attention for their excellent functional properties. The most promising technique used to prepare such nanoporous metals is dealloying in aqueous solution. Nanoporous noble metals including Au have been prepared from binary alloy precursors. The less noble metals, unstable in aqueous solution, are oxidized immediately when they contact water at a given potential so this process is only possible for noble metals. Porous structures with less noble metals such as Ti or Fe are highly desired for various applications including energy-harvesting devices. To overcome this limitation, a liquid metal dealloying (LMD) was developed in Kato lab. LMD is a selective dissolution phenomenon of a mono-phase alloy solid precursor: one component (referred as soluble component) being soluble in the metallic melt while the other (referred as targeted component) is not. When the solid precursor contacts the metallic melt, only atoms of the soluble component dissolve into the melt inducing a spontaneously organized bi-continuous structure at a microstructure level. The LMD has enabled the preparation of nanoporous structures in less noble metals such as Ti, Ni, Si, Fe, Nb, Co and Cr.

In this study, researchers from IMR Japan and INSA Lyon France made collaboration to clarify the mechanism of morphology formation during LMD process by taking the advantage of material preparation technique of IMR and material characterization technique of INSA Lyon. In IMR, porous materials were elaborated by the LMD process and microstructure, phase, compositional change was studied. In INSA Lyon, morphology of the porous materials was three dimensionally studied in-situ and ex-situ by using X-ray tomography.

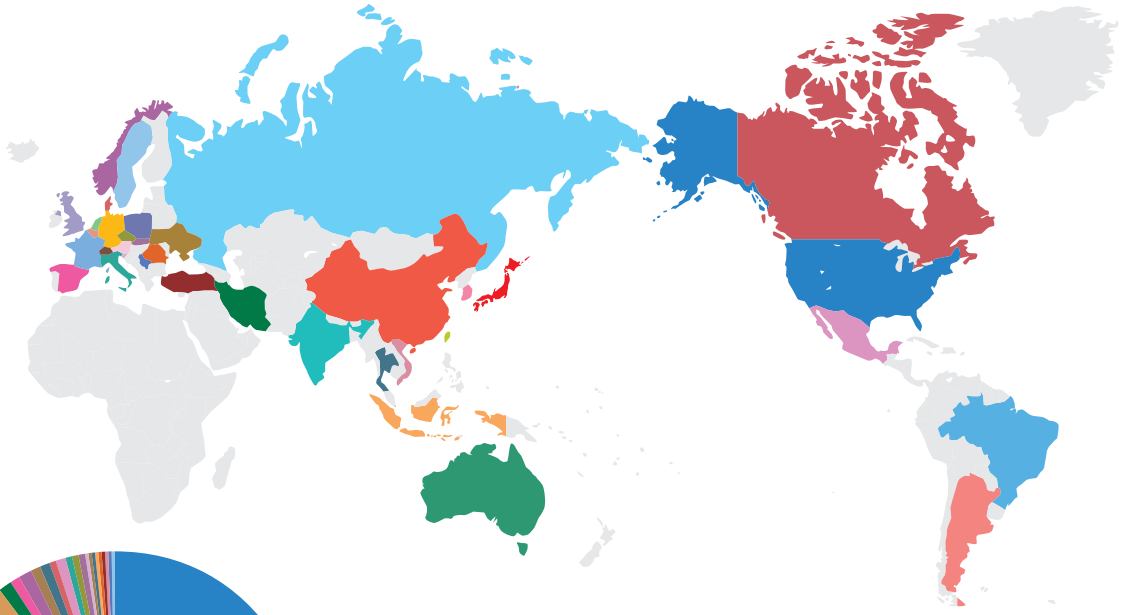
Figure 1(a) shows SEM image and reconstructed 3D structure (inset) of porous Fe-Cr alloy prepared from $Fe_{40}Cr_{10}Ni_{50}$ precursor. Two phases (metal and air) can be clearly distinguished in the reconstructed 3D image. This 3D morphological analyses allowed us to quantitatively evaluate volume fraction and of phases, surface area, connectivity and tortuosity more precisely than the 2D analyses done previously. Figure 1(b) shows experimental setup for 3D observation of dealloying process *in-situ*. The LMD cell was put into the intense X-ray beam line in European Synchrotron Radiation Facility (ESRF). The cell was heated by the laser and tomogram image was acquired. The bottom of Fig 1(b), shows the evolution porous metal layer in $Fe_{40}Cr_{10}Ni_{50}$ needle precursor at 45, 90 and 165 sec. The dark area and bright area in the needle sample corresponds to dealloyed porous metal and undealloyed layer, respectively. The thickness of porous metal layer linearly increase with time, indicating that the dealloying reaction kinetic was controlled by the interfacial reaction in this cell.



Appendix and acknowledgement

Figure 1(a) SEM image and reconstructed 3D structure (inset) of porous Fe-Cr alloy prepared from $Fe_{40}Cr_{10}Ni_{50}$ precursor. (b) top: experimental setup for 3D *in-situ* observation of dealloying in the ESRF beam line. bottom: evolution porous metal layer by LMD in the $Fe_{40}Cr_{10}Ni_{50}$ needle precursor in the longitudinal cross section at the different reaction time of 45, 90 and 165 sec. The transverse cross section image at 165 sec was also shown.

Visitors supported by ICC-Programs Graph on the world map



USA	91	Taiwan	8	Ukraine	2
China	83	Singapore	8	Argentina	1
Germany	74	Iran	6	Austria	1
France	68	Spain	6	Belgium	1
Korea	50	Norway	5	Brazil	1
UK	37	Hong-Kong	5	Indonesia	1
Russia	22	Thailand	5	Rumania	1
Netherlands	19	Denmark	4	Turkey	1
India	12	Mexico	4	Vietnam	1
Switzerland	12	Italy	3	Serbia	1
Poland	10	Czech Republic	3	Sweden	1
Canada	9	Slovakia	3		
Australia	9	Slovenia	2		

ICC-IMR Programs

ICC-IMR was founded in April 2008 as the center for international collaboration of the Institute for Materials Research (IMR). As one of the centers of excellence in material science, IMR holds 27 research groups and five research centers. ICC-IMR works as a gateway of diverse collaborations between international researchers and IMR members. ICC-IMR has invited 53 visiting professors and conducted 20 international research projects since the start-up. The applications are open for foreign researchers and the projects are evaluated by a peer-review process involving international reviewers. Currently, ICC-IMR coordinates six different programs:

1. **International Integrated Project Research**
2. **Visiting Professorship**
3. **Short Single Research Visits**
4. **International Workshops**
5. **Fellowship for young researcher and PhD student**
6. **Material Transfer Program**

We welcome applicants from around the globe to participate in these international programs.

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On the Cover

the UV-photon-excited Ce:
(Gd, La)2Si2O7 crystal grown
by the Czochralski process.
Photo Credit: Yoshikawa Laboratory, IMR