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ICC-IMR Director
Gerrit E. W.
BAUER

Top Message

International collaborative research has been an early victim of the COVID-19 pandemic. Many collaborators had to shift their arrival date sometimes more than once or even cancel it. Workshops were postponed or carried out fully online. While we hope that the global availability of vaccines will subdue the plague in a year or so, fundamental uncertainties remain. Will we go back to the previous modus of international collaborative research with human contact via frequent mutual visits? Or are we happy with the reduced costs and ecological damage, staying in our “nests” and communicate only virtually?

The “new normal” will probably be a mix of both, and the ICC must be flexible. We already introduced new programs, allowing financial and logistic support for online conferences. We help international students and postdocs with the financial burden of a two-week quarantine and COVID-19 testing when entering the country. We encourage Japanese

students who lack the opportunity to interact with foreign researchers by reimbursing costs of virtual activities and dissemination of their results. An ICC experiment (for which I have still mixed feelings) is the honorarium for foreign researchers that remotely collaborate with IMR staff. Time will tell what measures turn out to be effective and here to stay. We still offer the standard programs as in previous years:

Allow me to end with a personal note. After 10 years, I will retire from the IMR in March 2021. It has been an honor and a pleasure to serve as committee member and director of the ICC-IMR and be able to help carrying out the vision of the founders Prof. Maekawa and Prof. Nojiri. I would like to thank the trust and support of the IMR directors Prof. Takanashi and Prof. Furuhashi, the ICC committee members, and the real director, Ms. Motoko Honma.

❖ Comments from Visitors

In this News, visiting professors who have visited the IMR in the past gave us messages about their research activities and solutions under the COVID-19 pandemic.



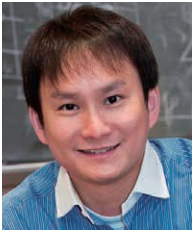
Ilya Okulov,
University of Bremen,
Germany and
Ural Federal University,
Russia

Our collaboration with Prof. Hidemi Kato from the Tohoku University began with an intriguing scientific discussion at an international conference back in 2016. We talked about challenges and opportunities of liquid metal dealloying – promising approach for synthesis of porous materials discovered in the group of Prof. Kato. To implement some of my research hypotheses, Prof. Kato invited me to visit his lab in 2017. Since my first visit, I have visited the Tohoku University several times. The pure research atmosphere at the Kato's lab, enables impactful inventions like synthesis of nanoporous high-entropy alloys published in *Advanced Materials* last year.

The whole last year was very different for all of us. It has affected everything, including our families, our relationships as well as the way we live and work. Certainly, the pandemic had a big impact on my research. Suddenly, at the beginning of pandemic, the German government informed us about lockdown and our labs were closed.

The uncertainty about the future impacted our minds and spirits. It is important to emphasize that my research is based on the lab work. So, I advised my students to focus on the theoretical part of their projects. I have also switched to the tasks which could be accomplished from home like writing articles and preparing research proposals.

Thanks to our IT team, the communication between home-isolated colleagues was rapidly improved by introduction of numerous communication channels, like Zoom, RocketChat, etc. During the first lockdown, the University of Bremen established clear rules to minimize impact of infection and enable the follow-up of the infection transmission chains. The number of people simultaneously presenting at the University of Bremen was significantly limited and everyone had to plan his/her lab visit in advance by filling out the online schedules. Every lab and working space was evaluated regarding the pandemic-safety and additional corona-briefings for each lab were introduced. This concerned the number of people simultaneously working in the lab, disinfection of working surfaces, required personal protective equipment, etc. Despite, the success of anti-pandemic measures at our university, the limited personal communication continues to impact our research. Hopefully, this year will provide us the opportunity to discuss our research and create new research hypotheses while sitting in front of each other (instead of screens) having a cup of tea or coffee.



Ruihua He,
Westlake University,
China

The pandemic would have a much bigger impact if I had chosen to continue with my old way of doing research. My past research was almost entirely based on the use of synchrotron user facilities where I mainly characterize materials with samples provided by collaborators including you. That was the case when I was a graduate student mainly performing experiments for thesis research at a nearby synchrotron, then did my postdoc working full-time at a synchrotron either taking beamtime or taking care of a beamline, and started up my own group at Boston College without a home system fully relying on travels all over the world for beamtime experiments. After I joined my current institution in 2018, I was given enough resources with which to equip my lab with both UHV characterization tools and thin film synthesis tools of different kinds. As a result, I had taken a U-turn in research by staying home for experiments and going out only occasionally for beamtime. The price I paid is two whole years working to design, purchase, build, commission, repair, recommission the huge system with pieces of different kinds all connected in UHV. I am proud to see

that it is eventually coming close to a completion (a photo attached). I also feel lucky that I have done this, otherwise my research had to come very close to a full stop due to the pandemic.

That being said, two of our beamtime experiments at UVSOR were severely affected. In one case, our beamtime got cancelled because the border was closed to foreigners and my team were not allowed to enter Japan. In the other, when we tried hard but at last figured that we would not be able to catch our beamtime in time due to the pro-longed quarantine, we gave up, mailed my samples in and had the favor of the beamline scientist to perform the experiment for us with me sitting aside for four days, of course, virtually. We managed to obtain some useful data through that experiment, although none of us used to do experiments this way and the efficiency is low.

With different sorts of travel restrictions in place, I cannot imagine there is a way to get back to the old normal when we were free to travel all over the world for experiments, collaborations, academic visits and conferences. An electronic COVID passport for each traveller which contains most updated diagnostic and immunization records is, probably, the ultimate solution for us to get around the blinded quarantine in the foreseeable future.



Mohamed Gepreel,
Egypt-Japan University of
Science and Technology,
Egypt.

I am so happy with the great opportunity given to me by ICC-IMR visiting professor program to visit IMR-Tohoku University again after I left it and Japan in Oct. 2010. It is really my pleasure to visit IMR as a researcher every now and then.

It was an honor to be back for research in the same prestigious place, but this time with a different research group, Prof. Akihiko Chiba group. The work environment is so encouraging and helpful due to the international nature of IMR groups. That is why I send my PhD students to stay for 6-9 months in IMR and conduct part of their PhD research work through a bilateral agreement. My visit added a lot to our link with IMR as a supporter to our current and future research projects. During my visit, I was able to do alloys production, processes, and characterization using advanced techniques (HRTEM, EPMA, thermomechanical simulator) for the low-cost high-entropy $Al_{(5+x)}Cr_{12}Fe_{35}Mn_{(28-x)}Ni_{20}$ alloys. The selected compositions are located along the fcc/(fcc+bcc)/bcc phase boundary. The yield stress of some

the alloys raised more than four times after cold rolling to 90%. In spite of its limited time, the visit was productive, it resulted in an international journal publication and the rest are coming, thanks to Prof. A. Chiba group continuous cooperation and support.

While the nice story above improved our research plane for better internationalization, we suddenly disturbed by the COVID-19 pandemic that changed completely our performance and planes. It was and still hard time, every thing is changing, even I lost one of my family members.

The safety measures made by the country and the university pushed us to find alternatives. As for teaching and meetings is through Zoom and Blackboard. I wrote review paper, applied for research projects, and try to contribute in developing tools to face COVID-19 such as needed virus killer (i.e., coating materials and air filter). As for the post graduate students, they worked on the literature review and continue research with slow rate but we have limitations in the advanced research facilities that was planned to be used during the students visit to IMR for 9 months, as planned, but this wasn't possible yet, which is a serious problem for the students research and time limit. I recommend in the current situation (with reduced persons mobility and face to face interaction) to encourage joint research and more samples mobility (I do for you and you do for me) with online meetings and discussion ends with benefit to all. We pray the situation to be much better soon for all.



Subhankar Bedanta,
NISER Bhubaneswar, India

The generation of pure spin current and its effect on the switching of the magnetization by spin transfer torque via spin orbital torque has been subject of vivid research in last one decade [1]. Heusler alloy based $\text{Co}_2\text{Fe}_x\text{Mn}_{1-x}\text{Si}$ (CFMS) has a low damping coefficient, therefore, we have prepared bilayers $\text{MgO}(100)/\text{CFMS}$ (20 nm)/Pt ($t_{\text{Pt}} = 3, 5, 7, 10, 20$ nm) for the investigations of spin pumping and inverse spin Hall effect (ISHE). Thin films of CFMS are grown using magnetron sputtering on $\text{MgO}(100)$ substrates in the lab of Prof. Takanashi. The samples were investigated for the damping properties and ISHE using ferromagnetic resonance (FMR) at NISER, India [2].

The presence of substantial spin pumping keeps the damping constant values in the order of $\sim 10^{-3}$. Figure 1 (a) and (b) show the Pt thickness dependence of effective spin mixing conductance ($g_{\text{eff}}^{\uparrow\downarrow}$) and

spin Hall angle (θ_{SH}), respectively. The data in Fig. 1(a) have been fitted to a spin back flow model in order to obtain spin mixing conductance ($g_r^{\uparrow\downarrow}$) at the CFMS/Pt interface [2]. We show that in CFMS/Pt the $g_r^{\uparrow\downarrow}$ ($1.70 \times 10^{20} \text{ m}^{-2}$) and interface transparency (83%) are higher compared to values reported for other ferromagnetic/heavy metal systems. We observed $\theta_{\text{SH}} \sim 0.026$ for CFMS/Pt bilayer system. Low magnetic damping and large value of $g_r^{\uparrow\downarrow}$ with high interface transparency make the CFMS/Pt system as a potential candidate for spintronic applications.

Acknowledgement: The support from ICC-IMR is highly appreciated. I also thank all the co-workers Dr. B. B. Singh, Mr. K. Roy, Mr. P. Gupta, Prof. T. Seki, and Prof. K. Takanashi.

References:

- [1] J. Sinova, S. O. Valenzuela, J. Wunderlich, C. H. Back, and T. Jungwirth, Rev. Mod. Phys. 87, 1213 (2015).
- [2] B. B. Singh, K. Roy, P. Gupta, T. Seki, K. Takanashi and S. Bedanta, NPG Asia Material (Nature publishing), in print.



Weerapong Chewpraditkul King Mongkut's University of
Technology Thonburi, Thailand

The short visit at IMR Tohoku University supported by the ICC-IMR program was very impressive, giving me the opportunity to strengthen the research collaboration with Prof. Akira Yoshikawa group.

During my time at the IMR Tohoku University, we successfully prepared the $\text{Y}_{0.8}\text{Gd}_{2.2}(\text{Al}_{5-x}\text{Ga}_x)\text{O}_{12}:\text{Ce},\text{Mg}$ garnet crystals using the micro-pulling-down method under kind assistance from Prof. Yoshikawa's laboratory staff, which we have a long period of collaboration. The scintillation characteristics were further characterized at KMUTT as well as at our collaborative research institutes in Czech Republic (Institute of Physics in Prague) and Poland (National Centre for Nuclear Research in Otwock and Institute of Physics at Nicolaus Copernicus University in Torun).

The aim of this work was focused on the scintillation properties of

the $\text{Y}_{0.8}\text{Gd}_{2.2}(\text{Al}_{5-x}\text{Ga}_x)\text{O}_{12}:\text{Ce},\text{Mg}$ garnet crystals. The best scintillation performance was obtained for the $\text{Y}_{0.8}\text{Gd}_{2.2}(\text{Al}_2\text{Ga}_3)\text{O}_{12}:\text{Ce},\text{Mg}$ sample, exhibiting high light yield value of 35,600 photons/MeV and fast scintillation decay times of 32 ns (52.4%) + 104 ns (47.6%). It shows good coincidence time resolution of 336 ps as measured in coincidence with a BaF_2 -PMT detector. The scientific result of my visit has been published in the peer-reviewed international journal.

I wish to express my sincere gratitude to the ICC-IMR and Yoshikawa laboratory staff for their kind hospitality during my stay in Sendai, a beautiful city forever remain in my memory.

❖ Topics

Summit of Materials Science SMS 2019 and Global Institute for Materials Research Tohoku (GIMRT) User Meeting 2019, Nov. 27-29, 2019



Invited/Keynote speakers

It was to the fourth Summit of Materials Science conferences that started with SMS2011, held in the years of the Great East Japan Earthquake.

The plenary session with 20 invited speakers from Japan and abroad as well as selected IMR faculty members attracted a large audience including many interested guests from outside the IMR.

The conference session on “Spintronics and Electronics”, “Nuclear Engineering”, “Structural Materials”, “Energy Materials and Crystal Growth”, “Quantum Beam and High Field” and “Recent Activities in Research Divisions and Centers” reflected the actual IMR research topics. Speakers were selected to represent cutting-edge research in those fields and IMR staff members used the opportunity to advertise ongoing research activities.

In the afternoon of the first day of the conference, young researchers and students presented their poster. More than 100 people gathered in the poster room to engage in heated discussions in front of the posters. A grand prizewinner and six merit award runners-up were selected from 67 competing abstracts.

The satellite workshop "GIMRTxISS-"Kibo" x AIRC" was held on the 29th. During the “Collaborative Research Platform on Ground and in Orbit” advanced research projects of three organizations were introduced and results on various topics of aerospace and materials science were presented. The lively exchange of ideas helped promoting future collaborations.

Participants unanimously appreciated the spirit and scope of this SMS conference and are looking forward to the next installment.



Poster presentation



Winners of the Young Scientist Poster Presentation Award



ICC-IMR Activities in FY 2019

Visiting Professors



Ruihua He

Westlake University, China
May 23, 2019- June 27, 2019

"Search for Materials with 3D Negative Electron Compressibility"
(Host: M. Fujita, IMR)



Ilya Okulov

The University of Bremen, Germany
May 8, 2019 - June 7, 2019

"Establishing a Hybrid Manufacturing Technology Combining Liquid Metal Dealloying and Additive Manufacturing for Production of Functional Nanoporous Materials" (Host: H. Kato, IMR)



Deng Pan

The Materials Genome Institute of Shanghai University, China
June 3, 2019 - August 30, 2019

"Processing- Dependence of Mechanical Properties and Governing Deformation Mechanisms of Ti-Nb Alloys by Additive Manufacturing"
(Host: A. Chiba, IMR)



Subhankar Bedanta

National Institute of Science Education and Research (NISER), India
June 17, 2019 - July 26, 2019

"Spin Pumping in Bi_2Se_3 (MoS₂)/CFMS Layers" (Host: K. Takanashi, IMR)



Jiang Xiao

Fudan University, China
August 1-31, 2019

"Spin Cavity" (Host: G.E.W. Bauer, IMR)



Ilya Sheikin

Le Laboratoire National des Champs Magnétiques Intenses, CNRS, France
July 1, 2019 - September 30

"Superconductivity, Quantum Phase Transitions and Fermi Surface of Strongly Correlated f -Electron Systems" (Host: D. Aoki, IMR)



Hyoung Seop Kim

Pohang University of Science and Technology, Korea
December 23, 2019 - January 31, 2020

"Ultrafine Grained Materials, High-Entropy Alloy"
(Host: H. Kato, IMR)



Ivan Soldatov

Leibniz Institute for Solid State and Materials Research, Dresden, Germany
February 3, 2020 - March 19, 2020

"Magnetic Domain Imaging of Ferrimagnetic Thin Films"
(Host: T. Takanashi, IMR)

Research Project

Quantum Matter Research under Extreme Conditions-Networking of Advanced Multiple Tools(2018-2020)

PI: J. Chang, Univ. of Zürich and H. Nojiri, IMR

Novel Spin Triplet Superconductivity in UTe₂ (2019-2020)

PI: J-P Brison, Univ. Grenoble Alpes & CEA-Grenoble and D. Aoki, IMR

Synthesis and Investigation of Biocompatible and Biodegradable Materials(2019-2021)

PI: J. Eckert, Erich Schmid Institute of Materials Science of the Austrian Academy of Sciences and H. Kato, IMR

International Workshop

Research Frontier of Advanced Spectroscopies for Correlated Electron Systems, June 13-15, 2019

Organizer: M. Fujita, IMR

J-Physics 2019 International Conference & KINKEN-WAKATE 2019 Multipole Physics, Kobe University, Sep. 17-21, 2019

Organizer: D. Aoki, IMR

15th International. Conference on Scintillating Materials and their Applications, SCINT2019, Sep.29 - Oct. 4, 2019

Organizer: A. Yoshikawa, IMR

The 4th International Symposium on Creation of Life Innovation Materials for Interdisciplinary and International Researcher Development(iLIM-4), Oct. 3-4, 2019

Organizer: H. Kato, IMR

KINKEN-KIST Joint Workshop 2019, KIST in Seoul, Oct. 29-30, 2019

Organizer: T. Sasaki, IMR

Summit of Materials Science 2019 and GIMRT User Meeting 2019, Nov. 27-29, 2019

Organizer: K. Takanashi, IMR

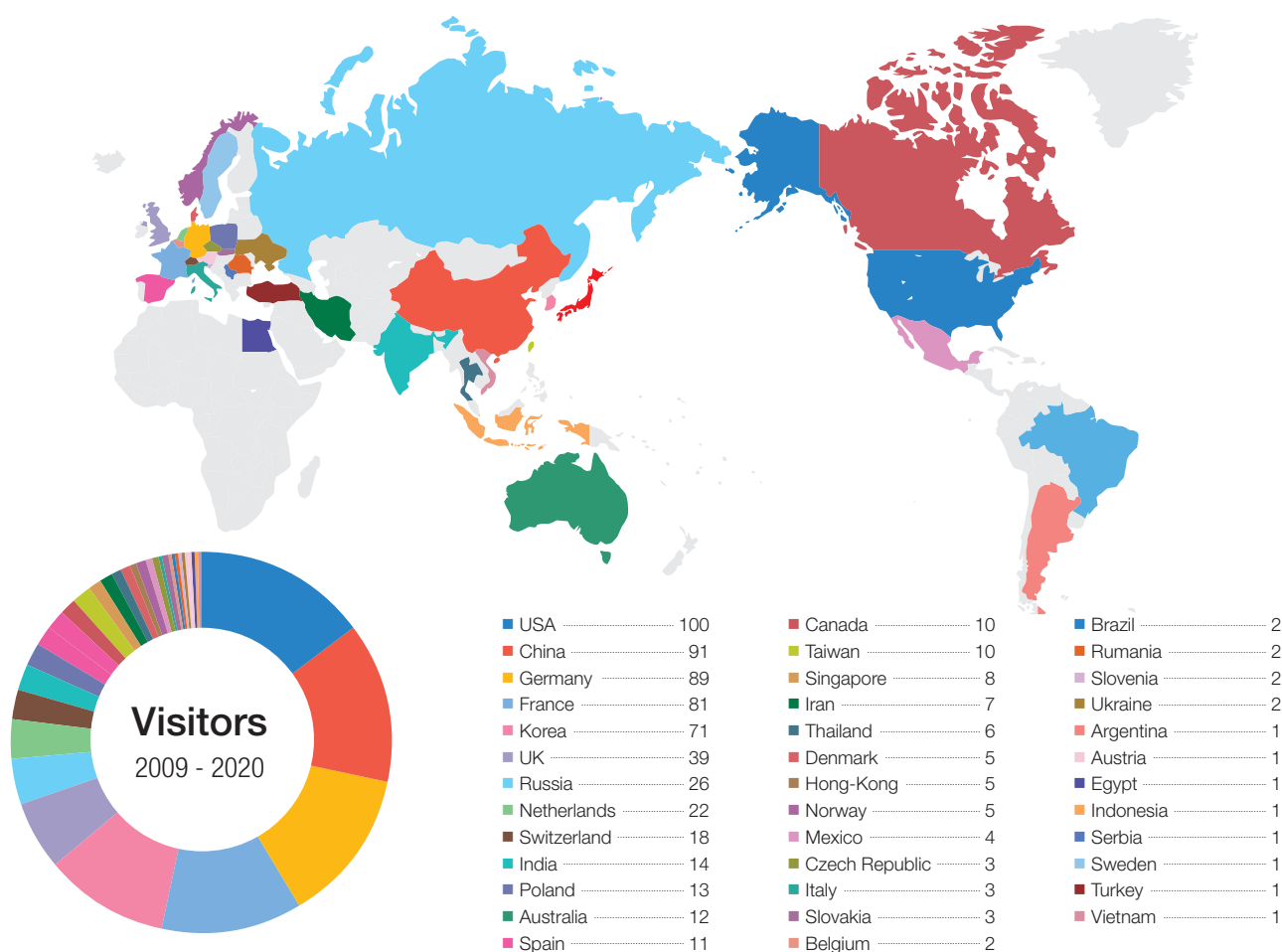
Making the Invisible Visible Together: Synergetic Collaboration Between Material and Synchrotron Science Through IMR-MAX IV Joint Research, Sendai, Jan. 14-15, 2020

Organizer: M. Fujita, IMR

The 3rd Symposium for The Core Research Clusters for Materials Science and Spintronics, Sendai, Feb. 9-11, 2020

Organizer: T. Sasaki, IMR

🌐 Visitors supported by ICC-Programs



🌐 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 67 visiting professors and conducted 23 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 five different programs:

- 1 International Integrated Project Research**
- 2 Visiting Professorships**
- 3 International Workshops**
- 4 Fellowships for Young Researchers and PhD Students**
- 5 Material Transfer Program**

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

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On the Cover

KS steel invented by Dr. Honda, the 1st director of IMR, Tohoku University, and words in his own handwriting. He left us the words "cherish the present" and "never stop trying".

