

# RMW11

The 11th Workshop on Reactive Metal Processing

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February 19 (Fri.) - 20 (Sat.), 2016 @ MIT  
Cambridge, Massachusetts, USA

## Organizers

**Donald R. Sadoway,** *Massachusetts Institute of Technology*  
**Toru H. Okabe,** *Institute of Industrial Science (IIS),  
The University of Tokyo*  
**Antoine Allanore,** *Massachusetts Institute of Technology*

## Program Coordinators

**Sakae Shirayama,** *The University of Tokyo*  
**Yu-ki Taninouchi,** *IIS, The University of Tokyo*

# The 11th Workshop on Reactive Metal Processing

February 19 (Fri.) – February 20 (Sat.), 2016, MIT, Cambridge, MA

## Time:

- 1st day: on February 19 (9:20 – 17:50 and Banquet in 18:30)
- 2nd day: on February 20 (9:20 – 13:00)

Refreshments will be served around 9:00 AM at the Grier room in both days.

## Venue:

- **Grier Room for Workshop (Building 34, Room 401)** (*see page 12*)  
Poster session is held at the Grier Room on February 19, 2016.

- **Le Meridien Hotel for Banquet**

(*see page 12 or [http:// www.lemeridiencambridge.com/](http://www.lemeridiencambridge.com/)*)

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**Prof. Donald R. Sadoway**, *Massachusetts Institute of Technology*

**Prof. Toru H. Okabe**, *IIS, The University of Tokyo*

**Prof. Antoine Allanore**, *Massachusetts Institute of Technology*

## Program Coordinators:

**Dr. Sakae Shirayama**, *The University of Tokyo*

**Dr. Yu-ki Taninouchi**, *IIS, The University of Tokyo*

## Sponsors:

- Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation by JSPS (P.I.: Prof. T.H. Okabe)
- The Rare Metal Research Workshop, one of the Special Research Group organized by the Foundation for the Promotion of Industrial Science (FPIS) (RC-40: directed by Prof. T.H. Okabe)
- Grant-in-Aid for Scientific Research (S) by JSPS (Project No. 26220910)
- The Strategic Partnerships Project of the Top Global University Project by The University of Tokyo

## Registration Fee:

\$200 / person (including banquet)

NOTICE: Please prepare to pay the registration fee in cash!

## Contact:

Sakae Shirayama, *The University of Tokyo*

E-mail: [shirayama@material.t.u-tokyo.ac.jp](mailto:shirayama@material.t.u-tokyo.ac.jp) Phone: +81-3-5841-8290

# Workshop Program

## Day 1

Morning, February 19 (Friday), 2016

@ Grier Room

9:00 – 9:20 **Coffee & Breakfast Service**

9:20 – 9:30 **Opening Remarks**

*Prof. Donald R. Sadoway*, Massachusetts Institute of Technology

*Prof. Toru H. Okabe*, IIS, The University of Tokyo

Session Chair: *Dr. Kouji Yasuda*

9:30 – 10:00 **“Reactive systems under own pressures”**

*Georges J. Kipouros*<sup>1</sup>

<sup>1</sup>University of Saskatchewan

10:00 – 10:30 **“Electrochemical properties of alkali/alkaline-earth element in liquid metals”**

*Hojong Kim*<sup>1</sup>

<sup>1</sup>The Pennsylvania State University

10:30 – 11:00 **“Fluorination behavior of actinide elements for fuel debris treatment”**

*Nobuaki Sato*<sup>1</sup>

<sup>1</sup>Institute of Multidisciplinary Research for Advanced Materials (IMRAM),  
Tohoku University

11:00 – 11:15 Break

Session Chair: *Dr. Adam C. Powell, IV*

11:15 – 11:45 **“Urban mining to recover metal values: Electrodeposition of tin and indium in molten chloride electrolytes”**

*Geir Martin Haarberg*<sup>1</sup> and *Bo Qin*<sup>2</sup>

<sup>1</sup>Norwegian University of Science and Technology (NTNU)

<sup>2</sup>Kunming University of Science and Technology

11:45 – 12:15 **“Behavior of impurities in aluminum electrowinning, and the effect on current efficiency”**

*Guðrún Sævarsdóttir*<sup>1</sup>

<sup>1</sup>Reykjavik University

12:15 – 13:15 Lunch

Session Chair: *Prof. Qian Xu*

13:15 – 13:45      **“Electrochemistry of liquid metals and molten salts”**

*Donald R. Sadoway*<sup>1</sup>

<sup>1</sup>Department of Materials Science and Engineering,  
Massachusetts Institute of Technology

13:45 – 14:15      **“Li-Bi for low-temperature liquid metal batteries”**

*Huayi Yin*<sup>1</sup>, *Brice Chung*<sup>1</sup>, and *Donald R. Sadoway*<sup>1</sup>

<sup>1</sup>Department of Materials Science and Engineering,  
Massachusetts Institute of Technology

14:15 – 14:30      Break

Session Chair: *Prof. Antoine Allanore*

14:30 – 15:00      **“Development of direct liquid steel production by electrolysis in molten oxides”**

*Jan Wiencke*<sup>1,2</sup>, *Hervé Lavelaine*<sup>1</sup>, *Pierre-Jean Panteix*<sup>2</sup>, *Carine Petitjean*<sup>2</sup>, and  
*Christophe Rapin*<sup>2</sup>

<sup>1</sup>ArcelorMittal Maizières

<sup>2</sup>Institut Jean Lamour, Université de Lorraine

15:00 – 15:30      **“Controlled molten oxidation of copper slag”**

*Yong Fan*<sup>1</sup>, *Etsuro Shibata*<sup>1</sup>, *Atsushi Iizuka*<sup>1</sup>, and *Takashi Nakamura*<sup>1</sup>

<sup>1</sup>Institute of Multidisciplinary Research for Advanced Materials (IMRAM),  
Tohoku University

15:30 – 16:00      Photo & Break

16:00 – 16:50      **3-min short presentation by poster presenters**

16:50 – 17:50      **Poster Session**

18:30 –              Banquet      @ Le Meridien Hotel

## Day 2

Morning, February 20 (Saturday), 2016

@ Grier room

9:00 – 9:20 **Coffee & Breakfast Service**

9:20 – 9:30 **Opening Remarks**

*Prof. Antoine Allanore*, Massachusetts Institute of Technology

Session Chair: *Prof. Geir Martin Haarberg*

9:30 – 10:00 **“Production of high-purity silicon via molten salt electrolysis”**

*Xiao Yang*<sup>1</sup>, *Kouji Yasuda*<sup>2,3</sup>, *Toshiyuki Nohira*<sup>1</sup>, *Rika Hagiwara*<sup>3</sup>, and *Takayuki Homma*<sup>4</sup>

<sup>1</sup>Institute of Advanced Energy, Kyoto University

<sup>2</sup>Environment, Safety and Health Organization, Kyoto University

<sup>3</sup>Graduate School of Energy Science, Kyoto University

<sup>4</sup>Faculty of Science and Engineering, Waseda University

10:00 – 10:30 **“Introduction to recent studies on recycling processes for metals in scraps of electronic devices and superconducting materials”**

*Hideaki Sasaki*<sup>1</sup>

<sup>1</sup>Institute of Industrial Science, The University of Tokyo

10:30 – 10:45 Break

Session Chair: *Prof. Georges J. Kipouros*

10:45 – 11:15 **“Recent progresses on electrochemistry of molten semiconductors”**

*Antoine Allanore*<sup>1</sup>

<sup>1</sup>Massachusetts Institute of Technology

11:15 – 11:45 **“Towards measurement of thermodynamic properties of molten rare earth oxides”**

*Bradley R. Nakanishi*<sup>1</sup> and *Antoine Allanore*<sup>1</sup>

<sup>1</sup>Department of Materials Science and Engineering,  
Massachusetts Institute of Technology

11:45 – 11:50 **Information for the Next RMW**

*Prof. Toru H. Okabe*, IIS, The University of Tokyo

11:50 – 12:00 **Closing Remarks**

*Prof. Donald R. Sadoway*, Massachusetts Institute of Technology

Afternoon, February 20 (Saturday), 2016

@ Grier Room

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12:00 – 13:00      Lunch

13:00 –            **Laboratory Tour (for applicants)**

## List of Poster Presentations

- 1. “Fundamental study on Bi-Ti-Zn ternary phase diagram for new smelting process of titanium”**  
*Akihiro Kishimoto*<sup>1</sup> and Tetsuya Uda<sup>1</sup>  
<sup>1</sup>Department of Materials Science and Engineering, Kyoto University
- 2. “Overpotential measurement for magnesium electrolysis on bismuth electrode”**  
*Kazuhiro Kumamoto*<sup>1</sup>, Akihiro Kishimoto<sup>1</sup>, and Tetsuya Uda<sup>1</sup>  
<sup>1</sup>Department of Materials Science and Engineering, Kyoto University
- 3. “Analysis of the hydration/dehydration behavior of lanthanum sulfate for chemical heat storage”**  
*Kunihiko Shizume*<sup>1</sup>, Naoyuki Hatada<sup>1</sup>, and Tetsuya Uda<sup>1</sup>  
<sup>1</sup>Department of Materials Science and Engineering, Kyoto University
- 4. “Electroplating of Si in high temperature fluoride-chloride melt”**  
*Kouji Yasuda*<sup>1,2</sup>, Kazumi Saeki<sup>2</sup>, Toshiyuki Nohira<sup>3</sup>, Rika Hagiwara<sup>2</sup>, and Takayuki Homma<sup>4</sup>  
<sup>1</sup>Environment, Safety and Health Organization, Kyoto University  
<sup>2</sup>Graduate School of Energy Science, Kyoto University  
<sup>3</sup>Institute of Advanced Energy, Kyoto University  
<sup>4</sup>Faculty of Science and Engineering, Waseda University
- 5. “Segregation refinement of Si utilizing liquid Zn”**  
*Kouji Yasuda*<sup>1,2</sup>, Akifumi Ido<sup>2</sup>, Xiao Yang<sup>3</sup>, Toshiyuki Nohira<sup>3</sup>, Rika Hagiwara<sup>2</sup>, and Takayuki Homma<sup>4</sup>  
<sup>1</sup>Environment, Safety and Health Organization, Kyoto University  
<sup>2</sup>Graduate School of Energy Science, Kyoto University  
<sup>3</sup>Institute of Advanced Energy, Kyoto University  
<sup>4</sup>Faculty of Science and Engineering, Waseda University
- 6. “Preparing silicide layers on metallic substrates using molten oxide electrolysis”**  
*Hideaki Sasaki*<sup>1</sup> and Masafumi Maeda<sup>1</sup>  
<sup>1</sup>Institute of Industrial Science, The University of Tokyo
- 7. “Thermodynamics of rare earth elements in nodular cast iron”**  
*Ng Kok Long*<sup>1,2</sup>, Hisao Kimura<sup>2</sup>, Hideaki Sasaki<sup>2</sup>, and Masafumi Maeda<sup>2</sup>  
<sup>1</sup>Department of Materials Engineering, The University of Tokyo  
<sup>2</sup>Institute of Industrial Science, The University of Tokyo

8. **“Investigation of the passivation mechanism of copper-based anodes from in-situ observations”**  
*Yuma Ninomiya*<sup>1,2</sup>, Hideaki Sasaki<sup>2</sup>, and Masafumi Maeda<sup>2</sup>  
<sup>1</sup>Department of Materials Engineering, The University of Tokyo  
<sup>2</sup>Institute of Industrial Science, The University of Tokyo
9. **“Thermodynamic properties of the CaO-AlO<sub>1.5</sub>-CeO<sub>1.5</sub> system”**  
*Ryo Kitano*<sup>1</sup> and Kazuki Morita<sup>1</sup>  
<sup>1</sup>Department of Materials Engineering, The University of Tokyo
10. **“Development of new technologies for high-speed production of copper”**  
*Kanta Iwaya*<sup>1,2</sup> and Toru H. Okabe<sup>2</sup>  
<sup>1</sup>Department of Materials Engineering, The University of Tokyo  
<sup>2</sup>Institute of Industrial Science, The University of Tokyo
11. **“Nickel and rhenium separation from nickel-based superalloy scraps using zinc circulation”**  
*Ryohei Yagi*<sup>1,2</sup> and Toru H. Okabe<sup>2</sup>  
<sup>1</sup>Department of Materials Engineering, The University of Tokyo  
<sup>2</sup>Institute of Industrial Science, The University of Tokyo
12. **“A review of the extraction of rare earth elements as a by-product of uranium mining”**  
*William D. Judge*<sup>1</sup> and Georges J. Kipouros<sup>1</sup>  
<sup>1</sup>Chemical Engineering, College of Engineering, University of Saskatchewan
13. **“Porous carbon anodes for the supply of methane during electrowinning of aluminium”**  
*Babak Khalaghi*<sup>1</sup>, Henrik Gudbrandsen<sup>2</sup>, Ole Sigmund Kjos<sup>2</sup>, Karen Sende Osen<sup>2</sup>,  
Tommy Mokkelbost<sup>2</sup>, and Geir Martin Haarberg<sup>1</sup>  
<sup>1</sup>Department of Materials Science and Engineering,  
Norwegian University of Science and Technology (NTNU)  
<sup>2</sup>SINTEF Materials and Chemistry
14. **“Electrochemically active surface area of carbon anodes in molten salt”**  
*Wojciech Gebarowski*<sup>1</sup>, Arne Petter Ratvik<sup>3</sup>, Stein Rørvik<sup>3</sup>, Espen Sandnes<sup>1</sup>,  
Lorentz Petter Lossius<sup>2</sup>, Hogne Linga<sup>2</sup>, and Ann Mari Svensson<sup>1</sup>  
<sup>1</sup>Department of Materials Science and Engineering,  
Norwegian University of Science and Technology (NTNU)  
<sup>2</sup>Hydro Aluminium  
<sup>3</sup>SINTEF Materials and Chemistry



**15. “Controllable electrolytic production of metal carbides and composites in molten salt”**

*Xingli Zou*<sup>1</sup>, *Xionggang Lu*<sup>1</sup>, *Qian Xu*<sup>1</sup>, and *Zhongfu Zhou*<sup>1</sup>

<sup>1</sup>State Key Laboratory of Advanced Special Steel,  
School of Materials Science and Engineering, Shanghai University

**16. “In situ measurements of current density distribution”**

*Brian Chmielowiec*<sup>1</sup> and *Antoine Allanore*<sup>1</sup>

<sup>1</sup>Department of Materials Science and Engineering, Massachusetts Institute of Technology

**17. “Electrodeposition/stripping of Mg in organic electrolytes for Mg batteries”**

*Shunsuke Yagi*<sup>1</sup>

<sup>1</sup>Nanoscience and Nanotechnology Research Center, Osaka Prefecture University

**18. “Alloying treatment for platinum by using FeCl<sub>2</sub> vapor”**

*Yu-ki Taninouchi*<sup>1</sup> and *Toru H. Okabe*<sup>1</sup>

<sup>1</sup>Institute of Industrial Science, The University of Tokyo

## History of RMW

- 2006 **The 1st Workshop on Reactive Metal Processing (RMW1)**  
March 17 (Fri.) - March 19 (Sat.), Cambridge, MIT
- 2006 **The 2nd Workshop on Reactive Metal Processing (RMW2)**  
November 16 (Thurs.) - November 17 (Fri.), Tokyo, The University of Tokyo
- 2007 **The 3rd Workshop on Reactive Metal Processing (RMW3)**  
March 2 (Fri.) - March 3 (Sat.), Cambridge, MIT
- 2008 **The 4th Workshop on Reactive Metal Processing (RMW4)**  
March 14 (Fri.) - March 15 (Sat.), Cambridge, MIT
- 2010 **The 5th Workshop on Reactive Metal Processing (RMW5)**  
February 18 (Thurs.) - February 19 (Fri.), Seattle, Red Lion Hotel on 5th Avenue
- 2011 **The 6th Workshop on Reactive Metal Processing (RMW6)**  
March 4 (Fri.) - March 5 (Sat.), Pasadena, Caltech
- 2012 **The 7th Workshop on Reactive Metal Processing (RMW7)**  
March 16 (Fri.) - March 17 (Sat.), Cambridge, MIT
- 2013 **The 8th Workshop on Reactive Metal Processing (RMW8)**  
March 8 (Fri.) - March 9 (Sat.), Cambridge, MIT
- 2014 **The 9th Workshop on Reactive Metal Processing (RMW9)**  
February 21 (Fri.) - February 22 (Sat.), Pasadena, Caltech
- 2015 **The 10th Workshop on Reactive Metal Processing (RMW10)**  
March 20 (Fri.) - March 21 (Sat.), Cambridge, MIT

**RMW1 in 2006 at MIT**



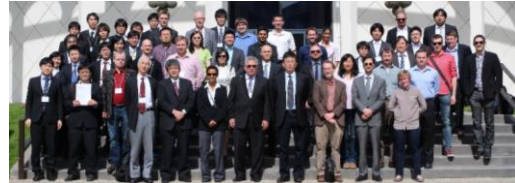
**RMW2 in 2006 at IIS**



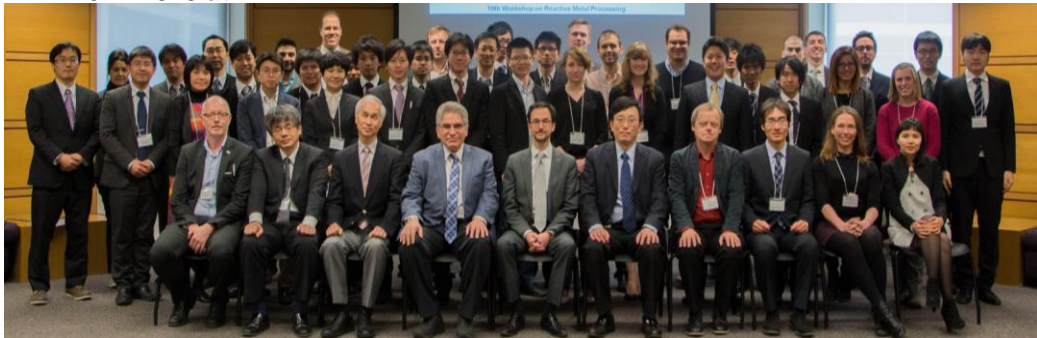
**RMW5 in 2010 in Seattle**



**RMW9 in 2014 at CALTECH**

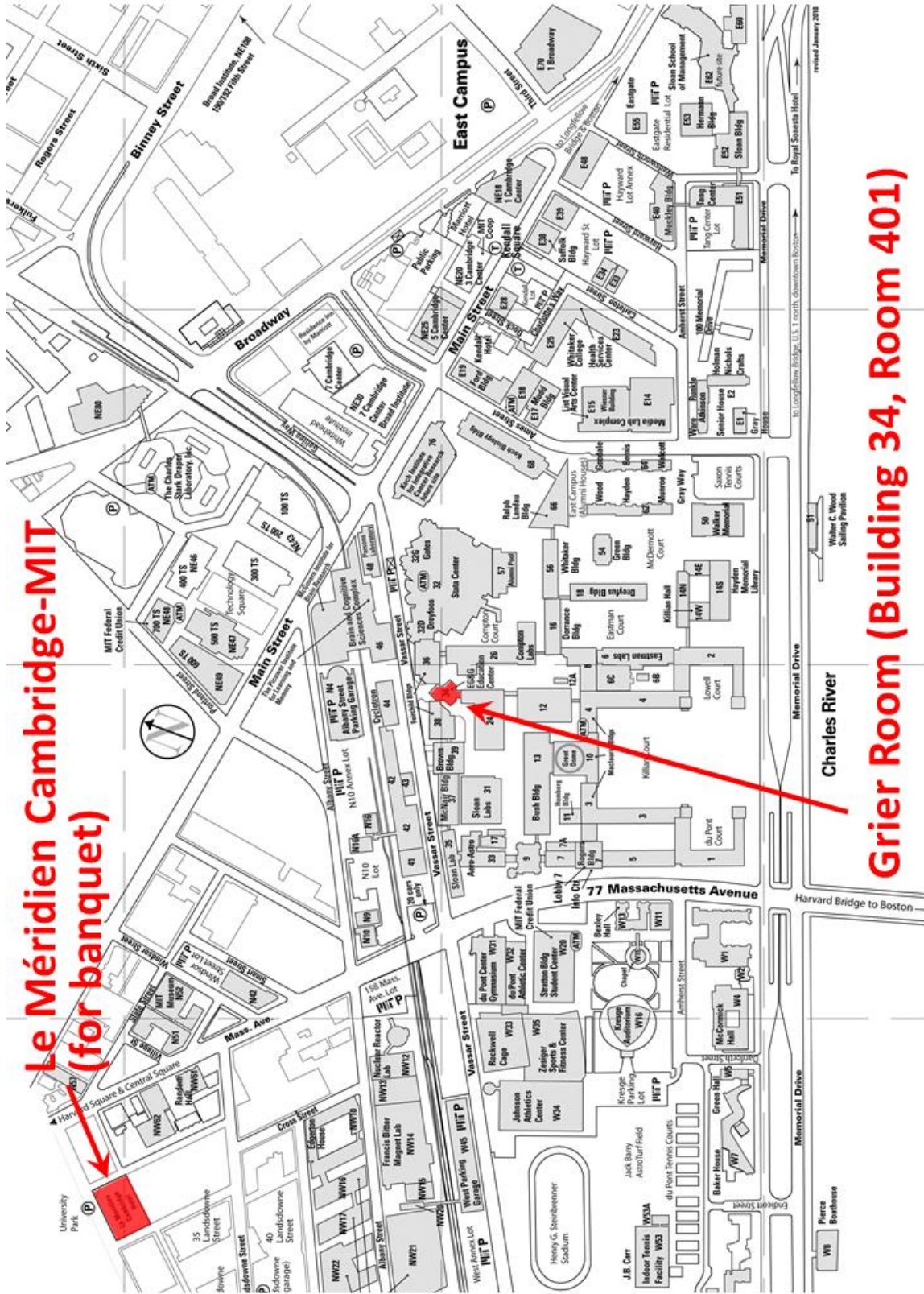


**RMW10 in 2015 at MIT**



Adam C. Powell, IV	Chief Technology Officer	INFINIUM, Inc.
Akihiro Kishimoto	Ph.D. Candidate	Kyoto University
Andrew H. Caldwell	Ph.D. Candidate	MIT
Antoine Allanore	Assistant Professor	MIT
Babak Khalaghi	Ph.D. Candidate	NTNU
Bradley R. Nakanishi	Ph.D. Candidate	MIT
Brian Chmielowiec	Research Engineer	MIT
Camilla Sommerseth	Researcher	SINTEF Materials and Chemistry
Donald R. Sadoway	Professor	MIT
Egil Skybakmoen	Research Director	SINTEF Materials and Chemistry
Fumio Iwamoto	Executive Chief Engineer	Sumitomo Metal Mining CO., LTD.
Geir M. Haarberg	Professor	NTNU
Georges J. Kipouros	Professor	University of Saskatchewan
Guðrún Sævarsdóttir	Professor	Reykjavik University
Hideaki Sasaki	Research Associate	The University of Tokyo
Hojong Kim	Assistant Professor	The Pennsylvania State University
Hilary Sheldon	Administrative Staff	MIT, Prof. Sadoway's secretary
Huayi Yin	Postdoctoral Associate	MIT
Jan Wiencke	Ph.D. Candidate	Université de Lorraine
Junjun Peng	Professor	Wuhan Textile University
Kanta Iwaya	Graduate Student	The University of Tokyo
Kathie McGregor	Group Leader	CSIRO
Katsuhiro Nose	Project Research Associate	The University of Tokyo
Kazuhiro Kumamoto	Graduate Student	Kyoto University
Kazuki Morita	Professor	The University of Tokyo
Kok Long Ng	Graduate Student	The University of Tokyo
Kouji Yasuda	Assistant Professor	Kyoto University
Kunihiko Shizume	Graduate Student	Kyoto University
Mana Inukai	Administrative Staff	The University of Tokyo
Minoru Kawasaki	President	NIPPON PGM AMERICA, Inc.
Nobuaki Sato	Professor	IMRAM, Tohoku University
Qian Xu	Professor	Shanghai University
Ryo Kitano	Graduate Student	The University of Tokyo
Ryo Togashi	Deputy Manager	Sumitomo Metal Mining CO., LTD.

Ryohei Yagi	Graduate Student	The University of Tokyo
Sakae Shirayama	Research Associate	The University of Tokyo
Shunsuke Yagi	Special Lecturer	Osaka Prefecture University
Sulata Kumari Sahu	Postdoctoral Associate	MIT
Takanari Ouchi	Research Scientist	MIT
Takayuki Hashimoto	Administrative Staff	The University of Tokyo
Tomoko Yanagisawa	Leader of Marketing Dept.	TANAKA HOLDINGS CO., Ltd.
Toru H. Okabe	Professor	The University of Tokyo
William Judge	Ph.D. Candidate	University of Saskatchewan
Wojciech Gebarowski	Postdoctoral Associate	NTNU
Xiao Yang	Project Research Associate	Kyoto University
Xingli Zou	Lecturer	Shanghai University
Yong Fan	Ph.D. Candidate	IMRAM, Tohoku University
Youyang Zhao	Ph.D. Candidate	MIT
Yu-ki Taninouchi	Research Associate	The University of Tokyo
Yuma Ninomiya	Graduate Student	The University of Tokyo



**Le Méridien Cambridge-MIT  
(for banquet)**

**Grier Room (Building 34, Room 401)**

# Announcement for Next Workshop

## RMW12

The 12th Workshop on  
Reactive Metal Processing



March 3 (Fri.) – 4 (Sat.), 2017 @ MIT, Cambridge

(After TMS 2017, February 26 – March 2, 2017  
@ San Diego, California)

Organizers

**Antoine Allanore**, *Massachusetts Institute of Technology*

**Shunsuke Yagi**, *IIS, The University of Tokyo*

**Toru H. Okabe**, *IIS, The University of Tokyo*

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**Bradley R. Nakanishi**, *Massachusetts Institute of Technology*

<http://www.okabe.iis.u-tokyo.ac.jp/core-to-core/rmw/>