

RMW15

The 15th Workshop on Reactive Metal Processing

February 28 (Fri.) - 29 (Sat.), 2020

@ UC San Diego, San Diego

February 26 (Wed.) - 27 (Thurs.), 2020 @ TMS

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*

Shunsuke Yagi, *IIS, The University of Tokyo*

Ying Shirley Meng, *University of California, San Diego*

Program Coordinators:

Takanari Ouchi, *IIS, The University of Tokyo*

Caspar Stinn, *Massachusetts Institute of Technology*

Sponsors

- The Rare Metal Research Workshop, one of the Special Research Group organized by the Foundation for the Promotion of Industrial Science (RC-40: directed by Prof. T. H. Okabe)
- Donation to The University of Tokyo New York Office by Dowa Metals & Mining Co., Ltd., Mitsubishi Materials Corporation, Sumitomo Metal Mining Co., Ltd., and Tanaka Kikinzoku Kogyo K.K..
- Grant-in-Aid for Scientific Research (S) by JSPS (Project No. 19H05623)
- Integrated Research Center for Sustainable Energy and Materials (IRCSEM)
- The Strategic Partnerships Project of the Top Global University Project by The University of Tokyo
- Institute of Industrial Science, The University of Tokyo (IIS UTokyo SYMPOSIUM No.105)

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

The 15th Workshop on Reactive Metal Processing (IIS UTokyo SYMPOSIUM No.105)

February 28 (Fri.) – February 29 (Sat.), 2020, UCSD, San Diego, CA

Time:

- 1st day: on February 28 (9:30 – 16:30 and Banquet at 19:00)
- 2nd day: on February 29 (9:30 – 13:30)

Refreshments will be served around 8:30 AM on both days.

Venue:

- **Cymer Conference Room (SME)**
- **La Jolla Shores Hotel**

(Transportation will be prepared by Organizers)

Registration Fee:

\$200 / person

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

Organizers:

- | | |
|---------------------------------|--|
| Prof. Donald R. Sadoway, | <i>Massachusetts Institute of Technology</i> |
| Prof. Toru H. Okabe, | <i>IIS, The University of Tokyo</i> |
| Prof. Antoine Allanore, | <i>Massachusetts Institute of Technology</i> |
| Prof. Shunsuke Yagi, | <i>IIS, The University of Tokyo</i> |
| Prof. Ying Shirley Meng | <i>University of California, San Diego</i> |

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Contact:

Caspar Stinn, *Massachusetts Institute of Technology*

E-mail: rmw@iis.u-tokyo.ac.jp

Workshop Program

Day 1

Morning, February 28 (Friday), 2020 @Cymer Conference Room (SME)

8:30 – 9:30 **Coffee & Breakfast Service**

9:30 – 9:40 **Opening Remarks**

Prof. Antoine Allanore

Massachusetts Institute of Technology

Prof. Ying Shirley Meng

University of California, San Diego

Session Chair: Prof. Antoine Allanore

9:40 – 10:10 **Advanced Characterization of Lithium Metal Anode and its Interphases with Electrolytes**

Ying Shirley Meng

University of California, San Diego

10:10 – 10:40 **Electrochemical Catalysts for Oxygen Reduction Reaction in Zinc-air Batteries**

Shunsuke Yagi

The University of Tokyo

10:40 – 10:55 **Break**

Session Chair: Prof. Hongmin Zhu

10:55 – 11:25 **Progress on Molten Sulfide Electrolysis**

Antoine Allanore

Massachusetts Institute of Technology

11:25 – 11:55 **Thermal Conductivity and Structure of Molten Oxides**

Kazuki Morita, Sakae Shirayama, Youngjo Kang, Youngjae Kim, Hodaka Aoki, Shun Ueda

The University of Tokyo

11:55 – 13:00 **Lunch**

Day 1

Afternoon, February 28 (Friday), 2020 @Cymer Conference Room (SME)

Session Chair: Prof. Toshiyuki Nohira

13:00 – 13:20 **Electrochemical deposition and morphology control in molten salts**

Hongmin Zhu

Tohoku University

13:20 – 13:40 **Aluminum production in times of climate change: how to reduce the carbon footprint**

Gudrun Saevarsdottir

Reykjavik University

Session Chair: Prof. Geir Martin Haarberg

13:40 – 14:00 **Magnesium Production and Recycling Technology**

Adam C. Powell IV

Worcester Polytechnic Institute

14:00 – 14:20 **Magnesiothermic Reduction of TiO₂ to High Purity Ti Assisted with Rare Earth Elements**

Takanari Ouchi, Takara Tanaka, Toru H. Okabe

The University of Tokyo

14:20 – 14:40 **Photo & Break**

14:40 – 15:40 **3-min Short Presentation by Poster Presenters**

15:40 – 16:40 **Poster Session at Cymer Conference Room (SME)**

16:45 – 17:45 **Charter bus travel from Cymer Conference Center to La Jolla Shores Hotel**

Pickup at 104 Lyman Ln, outside of SME building at loading dock

18:00 – **Reception** @ La Jolla Shores Hotel

18:30 – **Banquet** @ La Jolla Shores Hotel

Day 2

Morning, February 29 (Saturday), 2020 @Cymer Conference Room (SME)

8:30 – 9:30 **Coffee & Breakfast Service**

9:30 – 9:40 **Opening Remarks**

Prof. Shunsuke Yagi

IIS, The University of Tokyo

Session Chair: Prof. Shunsuke Yagi

9:40 – 10:10 **Development of Amide Ionic Liquids for Sodium and Potassium Secondary Batteries**

Toshiyuki Nohira

Kyoto University

10:10 – 10:40 **Selective Sulfidation for Ore Cracking, Metal Separation, and Recycling**

Caspar Stinn, Antoine Allanore

Massachusetts Institute of Technology

10:40 – 11:00 **Break**

Day 2

Session Chair: Prof. Georges J. Kipouros

- 11:00 – 11:20 **Urban mining of strategic materials from secondary resources**
Gisele Azimi
University of Toronto
Canceled: alternative talk was given by Prof. Kipouros
- 11:20 – 11:40 **Electrodeoxidation of Iron Oxide in Aqueous NaOH Electrolyte**
Geir Martin Haarberg
Norwegian University of Science and Technology (NTNU)
- 11:40 – 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
- 12:00 – 13:00 **Lunch**
- 13:00 – **Laboratory Tour (for applicants)**

List of Poster Presentations

- 1. “Application of ‘dry aqua regia’ - Pd treatment by FeCl₃-KCl and direct Pt recovery by FeCl₃-NaCl”**
*Akihiro Yoshimura*¹, Shunta Tochigi¹, Yasunari Matsuno¹
¹Graduate school of Engineering, Chiba University
- 2. “Production of Fine Titanium and Titanium Alloy Powders by the Shuttle of Disproportion Reaction in Molten Salt”**
*Xin Lu*¹, Tatsuya Sugimoto¹, Haochen Jiang¹, Takuya Ono¹, Osamu Takeda¹, Hongmin Zhu¹
¹Tohoku University, Japan
- 3. “High Performance, Low-Temperature, Lithium-Metal Primary Battery with Liquefied Gas Electrolytes”**
*Matthew Mayer*¹, Yije Yin², Baharak Sayahpour², Yangyuchen Yang², Dijo Damien¹, Daniel M. Davies¹, Ekaterina S. Sablina², Y. Shirley Meng^{1,2}
¹ Department of Nano Engineering, University of California San Diego
² Materials Science and Engineering, University of California San Diego
- 4. “Zr addition for enhanced B removal from Si by Si-Cu solvent refining”**
*Yongsheng Ren*¹ Kazuki Morita¹
¹Department of Materials Engineering, Graduate School of Engineering, The University of Tokyo
- 5. “Impurity Speciation in Petroleum Cokes using XAS Techniques XANES and EXAFS”**
Gøril JAHRSENGENE^{1,2}, Arne Petter RATVIK², Richard G. HAVERKAMP³ and Ann Mari SVENSSON¹
¹NTNU Norwegian University of Science and Technology, Department of Materials Science and Engineering
²SINTEF Industry, Trondheim, Norway
³Massey University, School of Engineering and Advanced Technology

List of Poster Presentations

6. **“Separation refining of crude $ZnCl_2$ by selective evaporation and deposition under vacuum”**
*Gen Kamimura*¹, Hiroyuki Matsuura¹
¹Department of Advanced Materials Science, The University of Tokyo
7. **“Recovery of Cobalt”**
*Karen Sende Osen*¹
¹SINTEF
8. **“Direct Production of an Aluminium- Titanium alloy by Electrolysis in a Laboratory Cell”**
*Omar Awayssa*¹, Gudrun Saevarsdottir², Geir Martin Haarberg¹
¹Department of Materials Science and Engineering, NTNU
²Reykjavik University, School of Science and Engineering
9. **“Investigation of the direct reduction process of TiO_2 to high purity Ti using rare earth elements”**
Takara Tanaka^{1,2}, Takanari Ouchi², and Toru H. Okabe²
¹Department of Materials Engineering, The University of Tokyo
² Institute of Industrial Science, The University of Tokyo
10. **“Effects of Fe Substitution on Electrochemical Properties of $Mg(M_{1-x}Fe_x)_2O_4$ (M = Mn, Co) Positive Electrodes for Mg Rechargeable Batteries”**
*Jonghyun Han*¹, Shunsuke Yagi¹, and Tetsu Ichitsubo²
¹ Institute of Industrial Science, The University of Tokyo
² Institute for Materials Research, Tohoku University
11. **“Comparative Study of AC and DC Solvers based on Current and Power Distributions in a Submerged Arc Furnace”**
*Yonatan Afework Tesfahunegn*¹
¹Department of Engineering, Reykjavik University

List of Poster Presentations

12. **“A rational design of three-dimensional current collector for lithium metal anode”**

*Bingyu Lu*¹

¹Laboratory for Energy Storage and Conversion, University of California, San Diego

13. **“Alumina Concentration Measurements in Cryolite Melts”**

*Luis Bracamonte*¹

¹NTNU

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
- 2016 **The 11th Workshop on Reactive Metal Processing (RMW11)**
February 19 (Fri.) - February 20 (Sat.), Cambridge, MIT
- 2017 **The 12th Workshop on Reactive Metal Processing (RMW12)**
March 3 (Fri.) - March 4 (Sat.), Cambridge, MIT
- 2018 **The 13th Workshop on Reactive Metal Processing (RMW13)**
March 16 (Fri.) - March 17 (Sat.), Cambridge, MIT
- 2019 **The 14th Workshop on Reactive Metal Processing (RMW14)**
March 15 (Fri.) - March 16 (Sat.), Cambridge, MIT

RMW1 in 2006 at MIT



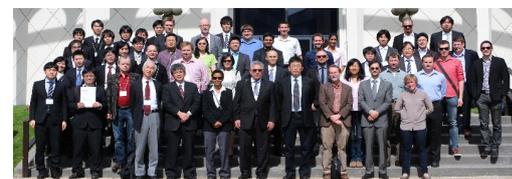
RMW2 in 2006 at IIS



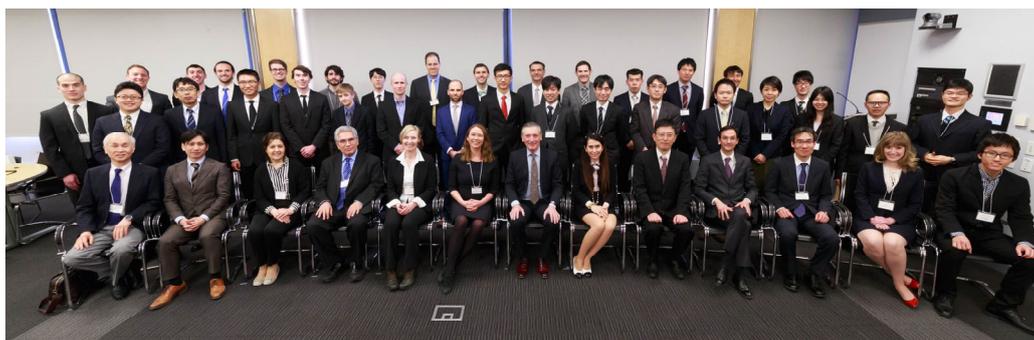
RMW5 in 2010 at Seattle



RMW9 in 2014 at CALTECH



RMW13 in 2018 at MIT



List of Participants

A. Semih Sunkar	Vice President	Nippon PGM America Inc.
Adam C. Powell, IV	Associate Professor	Worcester Polytechnic Institute
Aditya Moudgal	Graduate Student	Worcester Polytechnic Institute
Akihiro Yoshimura	Assistant Professor	Chiba University
Antoine Allanore	Associate Professor	MIT
Bingyu Lu	Graduate Student	UCSD
Caspar R. Stinn	Graduate Student	MIT
Christian Faria	Graduate Student	Worcester Polytechnic Institute
Donald R. Sadoway	Professor	MIT
Egil Skybakmoen	Research Manager	SINTEF
Espen Sandnes	Associate Professor	NTNU
Geir Martin Haarberg	Professor	NTNU
Gen Kamimura	Graduated student (PhD course)	The University of Tokyo
Gisele Azimi	Associate Professor	University of Toronto
Gøril Jahrsengene	Researcher	SINTEF
Gudrun Saevarsdottir	Associate Professor	Reykjavik University
Guillaume Lambotte	R&D Director	Boston Metal
Hojong Kim	Assistant Professor	Penn State
Hongmin Zhu	Professor	Tohoku University
Ji Zhao	Research Scientist	MIT
Jonathan Paras	Graduate Student	MIT
Jonghyun Han	Ph.D. Student	IIS, The University of Tokyo
Karen Sende Osen	Senior Research Scientist	SINTEF
Katie Daehn	Postdoctoral Associate	MIT
Kazuki Morita	Professor	The University of Tokyo
Luis Bracamonte	PhD Student	NTNU
Mai Tanaka	Administrative Staff	IIS, The University of Tokyo
Mary Elizabeth Wagner	PhD Candidate	MIT
Masatoshi Ueno	Managing Director	Komatsu, Ltd
Matt Mayer	PhD Student	UCSD
Michelle Chao	VP of Engineering	Phoenix Tailings Inc

List of Participants

Mike Martin	VP of Operations	Phoenix Tailings Inc
Omar Awayssa	PhD fellow	NTNU
Rebecca Miller		
Shiori Suzuki	Administrative Staff	IIS, The University of Tokyo
Shunsuke Yagi	Associate Professor	IIS, The University of Tokyo
Takanari Ouchi	Research Associate	IIS, The University of Tokyo
Takara Tanaka	Graduate Student	IIS, The University of Tokyo
Teppei Suzuki	Graduate Student	MIT
Thomas Villalon	CTO	Phoenix Tailings Inc
Toru H. Okabe	Professor	IIS, The University of Tokyo
Toshiyuki Nohira	Professor	Kyoto University
William Judge	PhD Candidate	University of Toronto
Xin Lu	Assistant Professor	Tohoku University
Y. Shirley Meng	Professor	UCSD
Yonatan Afework Tesfahunegn	Assistant Professor	Reykjavik University
Yong Fan	Germany Humboldt PhD Fellow	TU Freiberg
Yongsheng Ren	Ph.D. Candidate	The University of Tokyo
Yasuhiro Fukunaka	Adjunct Researcher	Waseda University
Georges J. Kipouros	Adjunct Professor	University of Waterloo