

RMW16



The 16th Workshop on Reactive Metal Processing

March 24 (Fri.) – 25 (Sat.), 2023 @ MIT

(After TMS 2023, March 19 (Sun.) – 23 (Thu.), 2023 @ San Diego, California)

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*

Program Coordinators:

Takanari Ouchi, *IIS, The University of Tokyo*

Gen Kamimura, *IIS, The University of Tokyo*

Isaac Oda-Bayliss, *IIS, The University of Tokyo*

Jonathan Paras, *Massachusetts Institute of Technology*

Sponsors

-The Rare Metal Research Workshop, one of the Special Research Groups organized by the Foundation for the Promotion of Industrial Science (FPIS) (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..

-Integrated Research Center for Sustainable Energy and Materials (SUSMAT)

-Institute of Industrial Science, The University of Tokyo (IIS UTokyo SYMPOSIUM No.113)

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

The 16th Workshop on Reactive Metal Processing (IIS UTokyo SYMPOSIUM No.113)

March 24 (Fri.) – March 25 (Sat.), 2023, MIT, Cambridge, MA

Time:

- 1st day: on March 24 (10:00 – 17:00 and Banquet at 18:30)
- 2nd day: on March 25 (10:00 – 14:00)

Refreshments will be served around 9:00 AM on both days.

Venue:

- **Haus Allen Room (MIT)**
- **Le Méridien Cambridge**

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> |

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| Takanari Ouchi, | <i>IIS, The University of Tokyo</i> |
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| Isaac Oda-Bayliss, | <i>IIS, The University of Tokyo</i> |
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Contact:

Isaac Oda-Bayliss, *IIS, The University of Tokyo*

E-mail: aisaku-oda@g.ecc.u-tokyo.ac.jp

Workshop Program

Day 1

Morning, March 24 (Friday), 2023 @ Haus Allen Room (MIT)

9:00 – 10:00 **Coffee & Breakfast Service**

10:00 – 10:10 **Opening Remarks**

Prof. Antoine Allanore

Massachusetts Institute of Technology

Session Chair: Prof. Antoine Allanore

10:10 – 10:40 **Aluminium-sulfur Battery for Long-duration Stationary Power Delivery**

Donald R. Sadoway

Massachusetts Institute of Technology

10:40 – 11:00 **Break**

Session Chair: Dr. Takanari Ouchi

11:00 – 11:30 **Recent Development of Positive Electrode Active Materials for Magnesium Rechargeable Batteries**

Shunsuke Yagi

IIS, The University of Tokyo

11:30 – 12:00 **Sulfidation Chemistry for Materials Processing**

Casper Stinn

Massachusetts Institute of Technology

12:00 – 13:00 **Lunch**

Session Chair: Prof. Geir Martin Haarberg

13:00 – 13:30 **Anodic Electrochemical Deposition and Its Application**

Takanari Ouchi

The University of Tokyo

13:30 – 14:00 **Aluminum Production with Oxygen Evolving Inert Anodes: Some Recent Developments**

Guðrún Sævarsdóttir

Reykjavik University, NTNU

14:00 – 14:20 **Photo & Break**

Session Chair: Dr. Gen Kamimura

14:20 – 15:20 **3-min Short Presentation by Poster Presenters**

15:20 – 16:20 **Poster Session at the Haus Room and Allen Room at Building 36**

18:00 – **Reception** @ Le Méridien Cambridge

18:30 – **Banquet** @ Le Méridien Cambridge

Day 2

Morning, March 25 (Saturday), 2023 @ Haus Allen Room (MIT)

9:00 – 10:00 **Coffee & Breakfast Service**

10:00 – 10:10 **Opening Remarks**

Prof. Shunsuke Yagi

IIS, The University of Tokyo

Session Chair: Prof. Shunsuke Yagi

10:10 – 10:40 **A Magnesium Clean Energy Ecosystem Vision**

Adam C. Powell IV

Worcester Polytechnic Institute

10:40 – 11:00 **Break**

Session Chair: Prof. Adam C. Powell IV

11:00 – 11:30 **Proposal for Mg Production in Japan**

Toshihide Takenaka

Kansai University

11:30 – 12:00 **Electrowinning of Aluminium and Carbon Footprint**

Geir Martin Haarberg

NTNU

12:00 – 12:10 **Information for the Next RMW**

Prof. Toru H. Okabe

IIS, The University of Tokyo

12:10 – 12:20 **Closing Remarks**

Prof. Donald R. Sadoway

Massachusetts Institute of Technology

12:20 – 13:30 **Lunch**

13:30 – **Laboratory Tour (for applicants)**

List of Poster Presentations

- 1. Investigation of α -MnO₂ cathode in Magnesium Rechargeable Batteries**
Isaac Oda-Bayliss^{1,2}, Shunsuke Yagi²,
¹Department of Materials Engineering, Graduate School of Engineering, The University of Tokyo,
²Institute of Industrial Science, The University of Tokyo
- 2. Metal Leaching and Multiple Effect Distillation for Neodymium Magnet Recycling**
Chinenye Chinwego¹, Emmanuel Offei Opoku¹,
¹Worcester Polytechnic Institute
- 3. Study of Diaphragm Material used in Na-Zn Liquid Metal battery (LMB) for Stationary Energy Storage**
*Cathrine KW Solem¹, Karen S. Osen¹, Wojciech Gebarowski¹, Henrik Gudbrandsen¹,
Ole S. Kjos¹, Camilla Sommerseth¹,*
¹SINTEF
- 4. Recovery of precious metals from scraps using electrochemical anodic deposition in molten salt electrolyte**
Yuka Kujiraoka^{1,2}, Takanari Ouchi², Toru H. Okabe²,
¹Department of Materials Engineering, Graduate School of Engineering, The University of Tokyo,
²Institute of Industrial Science, The University of Tokyo
- 5. Electrochemical recovery of Au and Ag from ore deposits using innovative Deep Eutectic Solvent ionic liquids**
Gøril Jahrsengene¹, Zhaohui Wang¹, Ana Maria Martinez¹,
¹SINTEF
- 6. Electrochemical Reduction of Iron Oxide for the Valorizing the Iron Fuel Cycle**
Akmal Irfan Majid¹,
¹Eindhoven University of Technology
- 7. Optimization of Ni Electrodeposition for Alkaline Water Electrolyzers**
Yukihiro Takahashi¹,
¹Norwegian University of Science and Technology (NTNU)
- 8. Recent technological developments for liquid displacement battery**
Kashif Mushtaq¹,
¹LEPABE, University of Porto, Portugal
- 9. Fundamental Study on Effects of Impurity on Zinc Electrowinning in Alkaline Bath**
Akihiro Kishimoto¹,
¹Department of Materials Science and Engineering, Kyoto University

List of Poster Presentations

- 10. Anodic Behavior of MoSi₂ Containing Nb in MgCl₂-NaCl-CaCl₂ Molten Salt**
*Shunsuke Irie*¹,
¹Kansai University Graduate School
- 11. Liquid metal Si deposition in molten CaCl₂ with the different molar ratio of CaO to SiO₂**
*Kosei Takahashi*¹,
¹Graduate School of Science and Engineering, Kansai University, Japan
- 12. Effect of impurities on Mg Metal Deposition in Molten Salt Electrolysis**
*Tatsuya Sasaki*¹,
¹Kansai University Graduate School
- 13. Advances in Magnesium Primary Production by Reactive Cathode Molten Salt Electrolysis with G-METS Distillation**
*Zujian Tang*¹, *Daniel McArthur Sehar*¹,
¹Worcester Polytechnic Institute
- 14. Numerical Modeling of Silicon Electrodeposition**
*Aditya Moudgal*¹,
¹Worcester Polytechnic Institute
- 15. Aluminum Electrolysis with Vertical Inert Electrodes – Recent Developments**
Daniel Þór Gunnarsson^{1,2}, *Guðmundur Gunnarsson*², *Jón Hjaltalín Magnússon*³,
*Kamaljeet Singh*¹, *Rauan Meirbekova*², *Roman Düssel*⁴, *Guðrun Sævarsdóttir*¹
¹Reykjavík University
²IceTec
³Arctus Aluminium
⁴TRIMET Aluminium SE
- 16. Investigation of Steel production via the Sulfide pathway**
*Kimaya P Suryarao*¹,
¹Massachusetts Institute of Technology (MIT)
- 17. LiF-BeF₂ Electrochemistry and Surrogate Materials Selection**
*Nathan Bradshaw*¹,
¹Massachusetts Institute of Technology (MIT)
- 18. MHD modelling of electric arcs in Submerged Arc Furnaces for Silicon Production**
*Hákon Valur Haraldsson*¹, *Guðrun Sævarsdóttir*¹, *Yonatan Afework Tesfahunegn*¹,
¹Reykjavík University and NTNU

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
- 2020 **The 15th Workshop on Reactive Metal Processing (RMW15)**
February 28 (Fri.) - February 29 (Sat.), San Diego, UC San Diego

RMW1 in 2006 at MIT



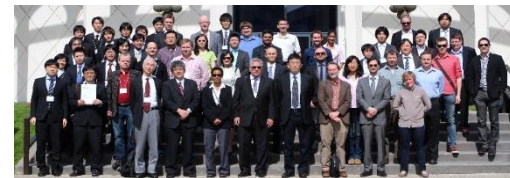
RMW2 in 2006 at IIS



RMW5 in 2010 at Seattle



RMW9 in 2014 at CALTECH



RMW15 in 2020 at San Diego



List of Participants

Adam C. Powell IV	Associate Professor	Worcester Polytechnic Institute
Aditya Moudgal	Graduate Student	Worcester Polytechnic Institute
Akihiro Kishimoto	Assistant Professor	Kyoto University
Akmal Irfan Majid	PhD Student	Eindhoven University of Technology
Alex Grant	CEO	Magrathea
Antoine Allanore	Professor	MIT
Ava Waitz	Graduate Research Assistant	MIT
Ayaka Sakamoto	Administrative Staff	IIS, The University of Tokyo
Brandon Velasquez	PhD Student	Reykjavik University
Caspar Stinn	PhD Candidate	MIT
Cathrine KW Solem	Research Scientist	SINTEF
Charles Boury	PhD Student	MIT
Chinenye Chinwego	PhD Candidate	Worcester Polytechnic Institute
Daniel McArthur Sehar	PhD Student	Worcester Polytechnic Institute
Daníel Þór Gunnarsson	Masters Student	Reykjavik University
Donald Sadoway	Chief Scientist	Sadoway Labs
Emmanuel Offei	Masters Student	Worcester Polytechnic Institute
Ethan Benderly-Kremen	PhD Candidate	Allanore Research Group
Geir Martin Haarberg	Professor	NTNU
Gen Kamimura	Research Associate	IIS, The University of Tokyo
Gøril Jahrsengene	Research Scientist	SINTEF
Gudrun Saevarsdottir	Professor	Reykjavik University and NTNU
Hákon Valur Haraldsson	PhD Student	Reykjavik University and NTNU
Haley Williams	PhD Student	UC Berkeley
Hiroyuki Iwasaki	Technical Advisor	KINA Corporation
Isaac Oda-Bayliss	Masters Student	IIS, The University of Tokyo
Jacob Brown	CTO	Magrathea
Jonathan Paras	PhD Student	MIT
Jumpei Matsumura	Research Scientist	Japan Aviation Electronics Industry, Ltd. (IIS)
Kamaljeet Singh	PhD Student	Reykjavik University and NTNU
Kashif Mushtaq	Post-doc Researcher	LEPABE, University of Porto
Kimaya P Suryarao	Research Assistant	MIT
Kosei Takahashi	Graduate Student	Kansai University Graduate School
Lucas Marden	Intern	Magrathea Metals

List of Participants

Masatoshi Ueno	Managing Director	Komatsu
Nathan Bradshaw	PhD Student	MIT
Porter Bowen	Undergraduate researcher	MIT
Ragnhild E. Aune	Professor	NTNU
Raluca O. Scarlat	Assistant Professor	UC Berkeley
Rochelle Zordich	Industry Advisor	WPI EMRG
Shinya Suzuki	Research Scientist	IIS, The University of Tokyo
Shunsuke Irie	Graduate Student	Kansai University Graduate School
Shunsuke Yagi	Associate Professor	IIS, The University of Tokyo
Takanari Ouchi	Lecturer	IIS, The University of Tokyo
Tatsuya Sasaki	Graduate Student	Kansai University Graduate School
Tomás Villalon Jr.	CTO, Co-Founder	Phoenix Tailings
Toru H. Okabe	Professor	IIS, The University of Tokyo
Toshihide Takenaka	Professor	Kansai University
Yonatan Afework Tesfahunegn	Research Scientist	Reykjavik University
Yuhei Terada	Administrative Staff	IIS, The University of Tokyo
Yuka Kujiraoka	Graduate Student	IIS, The University of Tokyo
Yukihiro Takahashi	PhD Candidate	NTNU
Zachary K Adams	Graduate Research Assistant	MIT
Zujian Tang	PhD Student	Worcester Polytechnic Institute

Venue Details

Workshop:

Haus Allen Room

Building 36, Room 462 (4th floor)

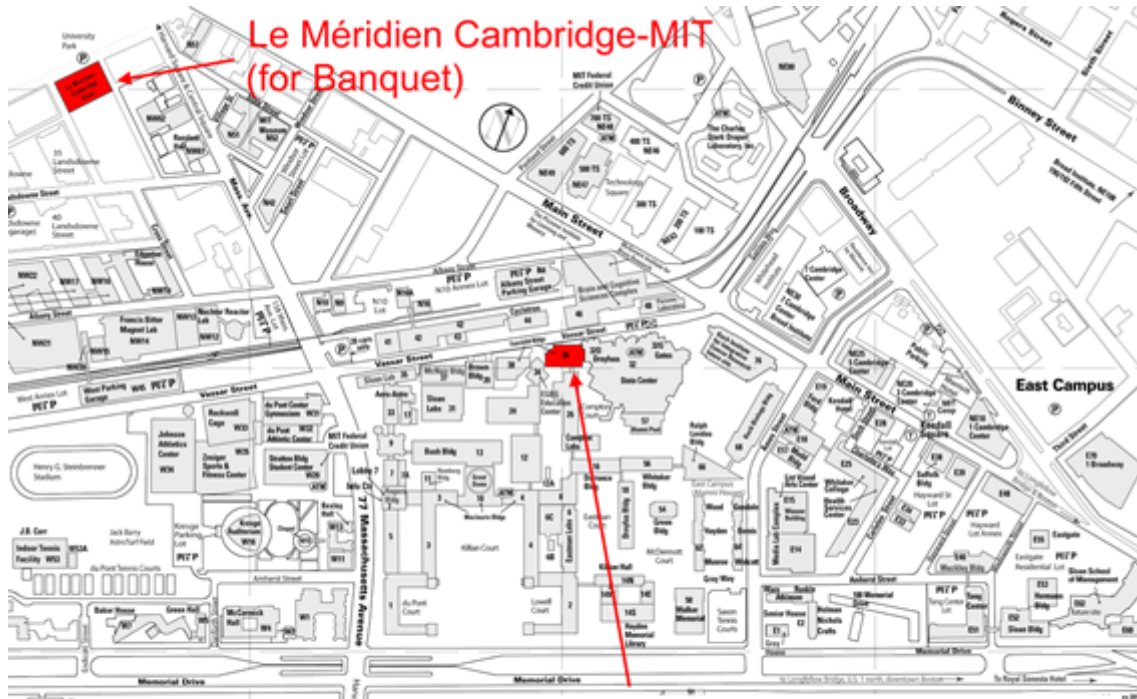
50 Vassar St, Cambridge, MA 02139

Interactive Campus Map available at: <http://whereis.mit.edu/>

Banquet:

Le Méridien Boston Cambridge

20 Sidney St, Cambridge, MA 02139



**Haus Allen Room, Building 36, Room 462
(for Workshop)**