

RMW8

The 8th Workshop on Reactive Metal Processing

March 8 (Fri.) - March 9 (Sat.), 2013 @ MIT

Cambridge, MA

Organizers

Donald R. Sadoway, *Massachusetts Institute of Technology*

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

Toshiyuki Nohira, *Graduate School of Energy Science, Kyoto University*

Program Coordinators

Kouji Yasuda, *Graduate School of Energy Science, Kyoto University*

Katsuhiro Nose, *IIS, the University of Tokyo*

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

The 8th Workshop on Reactive Metal Processing

March 8 (Friday) - March 9 (Saturday), 2013, MIT, Cambridge, MA

Time:

- 1st day: on March 8 (9:00 - 17:45 and 18:30 - Banquet)
- 2nd day: on March 9 (9:00 - 15:40)

Bread and coffee are prepared around 8:30 AM at the Grier room in both days.

Venue:

- **Grier Room (Building 34, Room 401) (for workshop)**

Building No.34 on Campus Map

Poster session is held on the outside of Grier Room.

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

<http://www.lemeridiencambridge.com/>

Organizers:

Prof. Donald R. Sadoway,

Massachusetts Institute of Technology

Prof. Toru H. Okabe,

Institute of Industrial Science, the University of Tokyo

Prof. Toshiyuki Nohira

Graduate School of Energy Science, Kyoto University

Program Coordinators:

Dr. Kouji Yasuda,

Graduate School of Energy Science, Kyoto University

Dr. Katsuhiro Nose,

Institute of Industrial Science, the University of Tokyo

Sponsor:

A part of the workshop is financially supported by the Rare Metal Research Workshop (RC-40: directed by Prof. Okabe), one of the Special Research Group organized by the Foundation for the Promotion of Industrial Science (FPIS). A part of the workshop is financially supported by the funding program for Next Generation World-Leading Researchers (NEXT program) by JSPS.

Registration Fee:

\$200 / person (including banquet)

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

Contact Address:

Kouji Yasuda, *Graduate School of Energy Science, Kyoto University*

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Workshop Program

Day 1

Morning, March 8 (Friday), 2013

@ Grier Room

8:30 – 9:00 **Coffee & Breakfast Service**

9:00 – 9:10 **Opening Remarks**

Prof. Donald R. Sadoway, Massachusetts Institute of Technology

Prof. Toru H. Okabe, Institute of Industrial Science, the University of Tokyo

Session Chair: *Prof. Toshiyuki Nohira*

9:10 – 9:40 **“Low Carbon Footprint Process for Metals Production”**

Uday B. Pal

Division of Materials Science and Engineering and the Department of Mechanical Engineering, Boston University

9:40 – 10:10 **“Electrochemical Behavior of Tin and Indium in Molten Chloride Electrolytes”**

*Geir Martin Haarberg*¹, Bo Qin¹, Ana Maria Martinez²

1: Department of Materials Science and Engineering, NTNU, 2: SINTEF

10:10 – 10:40 **“Systems Engineering for Scale-Up of the Infinium MagGen™ Primary Magnesium Production System”**

Adam C. Powell IV, Stephen J. Derezinski, III, R. Steve Tucker, Aaron Tajima
Infinium, Inc.

10:40 – 11:00 Break

Session Chair: *Prof. Guðrún Sævarsdóttir*

11:00 – 11:30 **“New Research Approaches”**

Georges J. Kipouros

Faculty of Engineering, Dalhousie University

11:30 – 12:00 **“TaON Based Nanostructures: Controllable Synthesis and Enhanced Visible-Light Photocatalytic Performance”**

Shuqiang Jiao and Jungang Hou

School of Metallurgical and Ecological Engineering, University of Science and Technology Beijing

12:00 – 13:15 Lunch

Session Chair: *Prof. Georges J. Kipouros*

13:15 – 13:45 **“A Consideration of Oxygen Activity in Various Molten Salts Including Slag”**

Takashi Nakamura

Institute of Multidisciplinary Research for Advanced Materials (IMRAM),
Tohoku University

13:45 – 14:15 **“An Insight into Oxygen Evolution Reaction in Molten Oxides”**

Antoine Allanore

Department of Materials Science and Engineering, Massachusetts Institute of
Technology

14:15 – 14:40 **“Calcium-based Liquid Metal Battery for Grid Scale Energy Storage: Ca-Mg||Bi, Sb, Pb”**

Takanari Ouchi, Hojong Kim, Nicholas Sather, Xiaohui Ning, Salvador Barriga,
Jocelyn M. Newhouse, Donald R. Sadoway

Department of Materials Science and Engineering, Massachusetts Institute of
Technology

14:40 – 15:05 **“Reduction of TiO₂ or TiCl_x into Liquid Bi in Molten Salts”**

Yuya Kado, Sho Maruyama, Akihiro Kishimoto, Tetsuya Uda

Graduate School of Engineering, Kyoto University

15:05 – 15:30 **“Oxide Metallurgy for the Production of Silicon”**

Kouji Yasuda^{1,2}, Toshiyuki Nohira², Rika Hagiwara²

1: Environment, Safety, and Health Organization, Kyoto University, 2: Graduate
School of Energy Science, Kyoto University

15:30 – 15:55 Photo & Break

Session Chair: *Dr. Katsuhiro Nose*

15:55 – 16:45 **3-min Short Presentation by Poster Presenters**

16:45 – 17:45 **Poster Session**

18:30 – Banquet @ Le Méridien Cambridge-MIT (Luscomb Ballrooms)

Day 2

Morning, March 9 (Saturday), 2013

@ Grier room

8:30 – 9:00 **Coffee & Breakfast Service**

9:00 – 9:10 **Opening Remarks**

Prof. Toshiyuki Nohira, Kyoto University

Session Chair: *Prof. Kazuki Morita*

9:10 – 9:40 **“Self Healing Liquid/Solid State Battery”**

*Paul Burke, Brice Chung, Xiaohui Ning, Satyajit Phadke, Huayi Yin,
Donald R. Sadoway*

*Department of Materials Science and Engineering, Massachusetts Institute of
Technology*

9:40 – 10:10 **“Materials Processing for Fuel Debris Treatment”**

Nobuaki Sato

*Institute of Multidisciplinary Research for Advanced Materials (IMRAM),
Tohoku University*

10:10 – 10:40 Break

Session Chair: *Prof. Geir M. Haarberg*

10:40 – 11:05 **“Electrochemical Synthesis of AB₅-type RE-Ni Based Alloys via FFC
Cambridge Process”**

Qian Xu, Xue Kang, Shuang Li, Ximei Yang, Qiushi Song

School of Materials and Metallurgy, Northeastern University

11:05 – 11:30 **“Application of Molten Oxide Electrolysis for Rare Earth Extraction”**

*Guillaume Lambotte, Tessa D. Green, Rachel DeLucas, Yen T. Yeh,
Donald R. Sadoway, Antoine Allanore*

*Department of Materials Science and Engineering, Massachusetts Institute of
Technology*

11:30 – 11:55 **“Mass Transport in Liquid Metal Batteries”**

Douglas H. Kelley, Nicholas A. Davis, Salvador Barriga, Donald R. Sadoway

*Department of Materials Science and Engineering, Massachusetts Institute of
Technology*

11:55 – 13:15 Lunch

Session Chair: *Prof. Tetsuya Uda*

- 13:15 – 13:40 **“Thermodynamics of Rhodium and Platinum in Molten Slags”**
Chompunoot Wiraseranee, Takeshi Yoshikawa, Toru H. Okabe, Kazuki Morita
 Institute of Industrial Science, the University of Tokyo
- 13:40 – 14:05 **“Electrochemical De-oxidation of Mixed Oxides to Fe–Ti Alloy in Molten Calcium Chloride Electrolyte”**
Mrutyunjay Panigrahi, Etsuro Shibata, Atsushi Iizuka, Takashi Nakamura
 Institute of Multidisciplinary Research for Advanced Materials (IMRAM),
 Tohoku University
- 14:05 – 14:30 **“Study of Rate Limiting Process in Liquid Metal Battery Systems”**
Jocelyn M. Newhouse, Hojong Kim, Donald R. Sadoway
 Department of Materials Science and Engineering, Massachusetts Institute of
 Technology
- 14:30 – 14:55 **“Low-Temperature Electrolytes for Liquid Metal Batteries”**
Brian Spatocco, Kimberly Aziz, Douglas H. Kelley, Paul Burke,
 Donald R. Sadoway
 Department of Materials Science and Engineering, Massachusetts Institute of
 Technology
- 14:55 – 15:20 **“Iron Removal from Titanium Ore to Prepare Titanium Dioxide through Selective Chlorination”**
Jung Shin Kang, Toru H. Okabe
 Institute of Industrial Science, the University of Tokyo
- 15:20 – 15:30 **Information for the Next RMW**
Prof. Tetsuya Uda, Kyoto University
- 15:30 – 15:40 **Closing Remarks**
Prof. Donald R. Sadoway, Massachusetts Institute of Technology
Prof. Toru H. Okabe, Institute of Industrial Science, the University of Tokyo
Prof. Toshiyuki Nohira, Kyoto University
- 16:00 – **Laboratory Tour (for applicants)**

List of Poster Presentations

1. **“Production of Magnesium and Oxygen by Solid Oxide Membrane Electrolysis with an Inert Current Collector”**
*Xiaofei Guan*¹, Uday B. Pal^{1,2}, Srikanth Gopalan^{1,2}
1: Division of Materials Science and Engineering, Boston University, 2: Department of Mechanical Engineering, Boston University
2. **“Recovery Process of Raremetals from Cemented Carbide Scraps Using Molten Metals”**
Kohei Matsutani, Yu-ki Taninouchi, Toru H. Okabe
Institute of Industrial Science, the University of Tokyo
3. **“Measurement of Thermodynamic Properties of Tellurium in Molten Iron by Transpiration Method”**
*Shumpei Suzuki*¹, Takeshi Yoshikawa¹, Takayuki Nishi², Kazuki Morita¹
1: Institute of Industrial Science, the University of Tokyo, 2: Nippon Steel & Sumitomo Metal Corporation
4. **“Electrorefining of Titanium from Bi-Ti Alloys in a NaCl-KCl Molten Salt”**
Akihiro Kishimoto, Yuya Kado, Shuhei Arisawa, Tetsuya Uda
Graduate School of Engineering, Kyoto University
5. **“A Study on Continuous Process for Electrolytic Reduction of SiO₂ Powder in Molten CaCl₂”**
*Tetsuya Toba*¹, Kouji Yasuda^{1,2}, Toshiyuki Nohira¹, Xiao Yang¹, Rika Hagiwara¹, Koki Ichitsubo³, Kenta Masuda³, Takayuki Homma⁴
1: Graduate School of Energy Science, Kyoto University, 2: Environment, Safety and Health Organization, Kyoto University, 3: Taiheiyo Cement Corp. 4: Faculty of Science and Engineering, Waseda University
6. **“Dry Recycling Process of Rare Earth Elements from Alloy Magnets”**
Keigo Nishimura, Toru H. Okabe
Institute of Industrial Science, the University of Tokyo
7. **“Production of Silicon by Solid Oxide Membrane-Based Electrolysis Process”**
*Yihong Jiang*¹, JiaPeng Xu¹, Xiaofei Guan¹, Uday B. Pal^{1,2}, Soumendra N. Basu^{1,2}
1: Division of Materials Science and Engineering, Boston University, 2: Department of Mechanical Engineering, Boston University
8. **“Reductive Removal of Phosphorus in Silicon Using CaO-CaF₂ Slag”**
Hiroaki Kawamura, Takeshi Yoshikawa, Kazuki Morita
Institute of Industrial Science, the University of Tokyo
9. **“Effect of Phosphorus Impurities on Current Efficiency in Aluminium Reduction Cells”**
*Rauan Meirbekova*¹, Guðrún Arnbjörg Sævarsdóttir¹, Geir Martin Haarberg², Petre Manolescu², Andrei Manolescu²
1: Reykjavik University, School of Science and Engineering, 2: Department of Materials Science and Engineering, NTNU

10. **“Fundamental Study on Anodic Dissolution Behavior of Platinum Group Metals in NaCl-KCl Fused Salt”**
Katsuhiro Nose, Toru H. Okabe
Institute of Industrial Science, the University of Tokyo
11. **“Solar Grade Silicon Purification Using Liquid Phase Migration Technique”**
Kunitoshi Matsunaga, Takeshi Yoshikawa, Kazuki Morita
Institute of Industrial Science, the University of Tokyo
12. **“New Production Process of Silicon Using Fine Powders of Silica and Calcium Hydride”**
*Yohsuke Mizutani*¹, Kouji Yasuda^{1,2}, Toshiyuki Nohira¹, Rika Hagiwara¹, Takayuki Homma³
1: Graduate School of Energy Science, Kyoto University, 2: Environment, Safety and Health Organization, Kyoto University, 3: Faculty of Science and Engineering, Waseda University
13. **“Review and Update of Hydrometallurgical Process for Nickel Laterite Ore”**
Yoshitomo Ozaki
Sumitomo Metal Mining Co., Ltd.
14. **“Zirconia Sensor Device for *in-situ* Monitoring of Metal Powder Oxidation States”**
Jarrold D. Milshtein^{1,2}, Soumendra N. Basu^{1,2}, Srikanth Gopalan^{1,2}, Uday B. Pal^{1,2}
1: Division of Materials Science and Engineering, Boston University, 2: Department of Mechanical Engineering, Boston University
15. **“A Technique for Recovering Rare Earth Elements from Rare Earth Permanent Magnets using B₂O₃ Flux”**
Hidehiro Sekimoto, Takahiro Kubo, Katsunori Yamaguchi
Department of Materials Science and Engineering, Faculty of Engineering, Iwate University
16. **“New Recycling Process of PGMs from Autoscrap”**
Akinari Suzue, Yu-ki Taninouchi, Toru H. Okabe
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



List of Participants

Allanore, Antoine	Assistant Professor	MIT
Aziz, Kimberly	Undergraduate Student	MIT
Barriga, Salvador	PhD Candidate	MIT
Blanchard, Allan	Undergraduate Student	MIT
Burke, Paul	Postdoctoral Associate	MIT
Chung, Brice	Visiting Scientist	MIT
Fonseca, Paula	PhD Candidate	MIT
Granata, Guiseppe	Postdoctoral Associate	Waseda University
Guan, Xiaofei	Graduate Student	Boston University
Haarberg, Geir M.	Professor	NTNU
Hou, Jungang	Assistant Professor	Univ. Sci. Tech. Beijing
Javed, Atif	Undergraduate Student	MIT
Jiao, Shuqiang	Professor	Univ. Sci. Tech. Beijing
Jiang, Yihong	Graduate Student	Boston University
Kado, Yuya	Postdoctoral Associate	Kyoto University
Kang, Jung Shin	PhD Candidate	IIS, the University of Tokyo
Kawamura, Hiroaki	Graduate Student	IIS, the University of Tokyo
Kelly, Douglas	Postdoctoral Associate	MIT
Kim, Hojong	Research Scientist	MIT
Kipouros, Georges J.	Professor	Dalhousie University
Kishimoto, Akihiro	Graduate Student	Kyoto University
Konno, Toru	Administrative Staff	IMRAM, Tohoku University
Kubo Junichi	Researcher	Sanoh Industrial Co., Ltd.
Lai, Erica	Undergraduate Student	MIT
Lambotte, Guillaume	Postdoctoral Associate	MIT
Li, Kejing	Postdoctoral Associate	MIT
Matsunaga, Kunitoshi	Graduate Student	IIS, the University of Tokyo
Matsutani, Kohei	Graduate Student	IIS, the University of Tokyo
Meirbekova, Rauan	PhD Candidate	Reykjavik University
Milshtein, Jarrod D.	Graduate Student	Boston University
Mizutani, Yohsuke	Graduate Student	Kyoto University
Morita, Kazuki	Professor	IIS, the University of Tokyo
Nakamura, Takashi	Professor	IMRAM, Tohoku University
Newhouse, Jocelyn M.	PhD Candidate	MIT
Nishimura, Keigo	Undergraduate Student	IIS, the University of Tokyo
Nohira, Toshiyuki	Associate Professor	Kyoto University
Nose, Katsuhiro	Project Research Associate	IIS, the University of Tokyo
Ohtsuka, Kyouichi	Administrative Staff	IMRAM, Tohoku University
Okabe, Toru H.	Professor	IIS, the University of Tokyo
Osada, Akemi	Administrative Staff	IIS, the University of Tokyo
Ouchi, Takanari	Postdoctoral Associate	MIT
Ozaki, Yoshitomo	PhD Candidate	IIS, the University of Tokyo
Pal, Uday B.	Professor	Boston University
Panigrahi, Mrutyunjay	PhD Candidate	IMRAM, Tohoku University

List of Participants

Powell IV, Adam C.	CTO	Infinium
Rogosic, John	PhD Candidate	MIT
Rosenberg, Rebecca		Prof. Sadoway's spouse
Sadoway, Donald R.	John F. Elliott Professor of Materials Chemistry	MIT
Sævarsdóttir, Guðrún	Associate Professor	Reykjavik University
Sato, Akihiro	Vice President	Business Department Division, IHI Inc.
Sato, Mitsuru	Specially Appointed Professor	IMRAM, Tohoku University
Sato, Nobuaki	Associate Professor	IMRAM, Tohoku University
Sekimoto, Hidehiro	Assistant Professor	Iwate University
Sheldon, Hilary	Administrative Staff	MIT, Prof. Sadoway's secretary
Shizhao, Su	Graduate Student	Boston University
Skorina, Taisiya	Postdoctoral Associate	MIT
Spatocco, Brian	PhD Candidate	MIT
Stokes, Rebecca	Postdoctoral Associate	MIT
Suzue, Akinari	Graduate Student	IIS, the University of Tokyo
Suzuki, Shumpei	Graduate Student	IIS, the University of Tokyo
Taninouchi, Yu-ki	Assistant Professor	IIS, the University of Tokyo
Toba, Tetsuya	Graduate Student	Kyoto University
Tucker, R. Steve	Engineer	Infinium
Uda, Tetsuya	Associate Professor	Kyoto University
Ueno, Masatoshi	Senior Manager	AGC America Inc.
Wagatsuma, Yumi	Administrative Staff	IIS, the University of Tokyo
Wang, Dihua	Professor	Wuhan University
Wiraseranee, Chompunoot	PhD Candidate	IIS, the University of Tokyo
Xu, Qian	Professor	Northeastern University
Yagi, Hiroshi	Administrative Staff	IMRAM, Tohoku University
Yamasue, Eiji	Assistant Professor	Kyoto University
Yanaba, Yutaka	Technical Associate	IIS, the University of Tokyo
Yasuda, Kouji	Assistant Professor	Kyoto University
Yeh, Yen T.	Undergraduate Student	MIT
Yin, Huayi	Postdoctoral Associate	MIT
Zink, Peter A.	Research Assistant Professor	Boston University

Announcement for Next Workshop

RMW9

The 9th Workshop on
Reactive Metal Processing



February 21 (Fri) – 22 (Sat), 2014 @ Caltech, Pasadena, CA
(After TMS2014, February 16 – 20, 2014 @ San Diego, California)

Organizers

Donald R. Sadoway, *Massachusetts Institute of Technology*

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

Sossina M. Haile, *California Institute of Technology*

Tetsuya Uda, *Kyoto University*

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