
Molten Salts 15: In Memory of Robert Osteryoung

Editors:

R. Mantz

Army Research Office
Durham, North Carolina, USA

H. De Long

AFOSR/NL
Arlington, Virginia, USA

R. Hagiwara

Kyoto University
Kyoto, Japan

G. Stafford

National Institute of Standards and Technology
Gaithersburg, Maryland, USA

P. Trulove

U.S. Naval Academy
Annapolis, Maryland, USA

D. Fox

American University
Washington, DC, USA

Sponsoring Divisions:

**Physical and Analytical Electrochemistry****Electrodeposition****High Temperature Materials****Battery****Energy Technology**

Published by

The Electrochemical Society

65 South Main Street, Building D
Pennington, NJ 08534-2839, USA

tel 609 737 1902

fax 609 737 2743

www.electrochem.org

ecs transactions™

Vol. 3 No. 35

Copyright 2007 by The Electrochemical Society, Inc.
All rights reserved.

This book has been registered with Copyright Clearance Center, Inc.
For further information, please contact the Copyright Clearance Center,
Salem, Massachusetts.

Published by:

The Electrochemical Society, Inc.
65 South Main Street
Pennington, New Jersey 08534-2839, USA

Telephone 609.737.1902
Fax 609.737.2743
e-mail: ecs@electrochem.org
Web: www.electrochem.org

ISSN 1938-6737 (online)
ISSN 1938-5862 (print)

Printed in the United States of America.

ECS Transactions, Volume 3, Issue 35
Molten Salts 15, in Memory of Robert Osteryoung

Table of Contents

Preface	iii
---------	-----

**Chapter 1
Max Bredig Award**

Molten Salts and Ionic Liquids - Are They Not the Same Thing? <i>J. S. Wilkes</i>	3
--	---

**Chapter 2
Novel Applications of Molten Salts and Ionic Liquids**

The Preparation and Characterization of Bombyx Mori Silk Nanocomposites Using Ionic Liquids <i>D. Fox, P. Fylstra, M. Hanley, W. A. Henderson, P. C. Trulove, S. Bellayer, J. Gilman and H. C. De Long</i>	11
Development of Low Melting Ionic Liquids using Eutectic Mixtures of Imidazolium and Pyrazolium Ionic Liquids <i>T. J. Dunstan and J. Caja</i>	21
Fulleride Based Ionic Liquids <i>R. E. Del Sesto, C. A. Corley, D. S. Dudis, A. T. Yeates and J. S. Wilkes</i>	33
Amino Acid Based Ionic Liquids: Solvents for Improved Biopolymer Dissolution <i>M. Hanley, J. M. Green III, W. A. Henderson, D. Fox, H. C. De Long and P. C. Trulove</i>	41
Flue Gas Cleaning With Alternative Processes and Reaction Media <i>S. Rasmussen, J. Huang, A. Riisager, H. Hamma, J. Rogez, J. Winnick, P. Wasserscheid and R. Fehrmann</i>	49
Decomposition of 2,4',5-Trichlorobiphenyl by Using Molten Salt <i>Y. Yokka, M. Kimura and Y. Sato</i>	61

Chapter 3

Structure and Properties of Molten Salts and Ionic Liquids

About the Acidity Level in Room Temperature Ionic Liquids <i>T. Robert, H. Olivier-Bourbigou, L. Magna and B. Gilbert</i>	71
What Makes an Ionic Liquid a Liquid? The Impact of Structure on Ionic Liquid Properties <i>W. A. Henderson, P. C. Trulove, H. C. De Long and V. Young Jr.</i>	83
Ordered Structure in Room Temperature Molten Salts Containing Aliphatic Quaternary Ammonium Ions <i>M. Mizuhata, M. Maekawa and S. Deki</i>	89
Molecular Modeling of Interactions between Ionic Liquids and Metal Surfaces <i>W. R. Carper and N. Nooruddin</i>	97
Characterization of Flammability Properties of Ionic Liquids <i>J. Gilman, D. Fox, A. Morgan, J. R. Shields, P. H. Maupin, R. E. Lyon, H. C. De Long and P. C. Trulove</i>	105
Preparation of Functionally Graded Aluminum Nitride-Oxide Coatings Using a Precursor Derived from a Chloroaluminate Ionic Liquid <i>M. T. Carter, C. Evenson and E. Schutte</i>	117
Ionic Liquid Impregnated Resins in Solid-Liquid Separations <i>V. A. Cocalia and R. D. Rogers</i>	123
The Ho ³⁺ Hypersensitive Transitions as Structural Probes for Molten Rare-Earth Ahlorides <i>G. N. Papatheodorou and A. G. Kalampounias</i>	135
A Polarizable-Ion Potential for Trihalides: from Clusters to Liquid Structure <i>Z. Akdeniz, R. Ruberto, G. Pastore and M. Tosi</i>	145
Empirical Evaluation of the Cryolite Melts Properties <i>A. A. Redkin, Y. Zaikov, O. Tkatcheva and E. Filatov</i>	153
Quantum Chemical Studies of Li Ion Hopping Mechanism in Polymer Electrolytes <i>P. Redfern, T. Kupka and L. A. Curtiss</i>	163
Physicochemical Properties of Molten KF-K ₂ NbF ₇ -Nb ₂ O ₅ System <i>B. Kubikova, J. Cibulkova, V. Danek and M. Gaune-Escard</i>	169

Chapter 4

Power Applications of Molten Salts and Ionic Liquids

Ionic Melt Electrolytes for Lithium Battery Applications <i>S. Creager, B. B. Hallac, O. Geiculescu, R. Rama, M. Herath and D. D. DesMarteau</i>	181
Ionic Liquid Fluorohydrogenates and Their Applications <i>R. Hagiwara, T. Nohira, T. Shimada, T. Fujinaga, S. Konno and T. Tsuda</i>	187
Dependence of Oxygen Reduction Reaction on Temperature in (Li/Na/La)CO ₃ <i>S. Mitsushima, S. Okuno, N. Kamiya and K. Ota</i>	195
Screening and Properties of New Materials for MCFC Application <i>V. Albin, A. Goux, S. Belair, V. Lair, A. Ringuedé and M. Cassir</i>	205

Chapter 5

Electrodeposition from Molten Salts and Ionic Liquids

Progress in Surface Finishing with Lewis Acidic Room-Temperature Chloroaluminate Ionic Liquids <i>T. Tsuda, C. L. Hussey and G. R. Stafford</i>	217
Practical Aluminum Plating from a Room Temperature Ionic Liquid <i>M. T. Carter and G. Bourgon</i>	233
Electrodeposition of Tin from 1-Methyl-3-ethylimidazolium Chloride/AlCl ₃ /SnCl ₂ Room Temperature Molten Salts <i>D. Zhu, H. Sun and Y. Fung</i>	239
Electrodeposition of In-Sn Alloys in EMI-BF ₄ -Cl Ambient Temperature Melts with Current Pulses <i>M. Noda, M. Morimitsu and M. Matsunaga</i>	249
Nickel Electrodeposition from a Room Temperature Eutectic Melt <i>A. Bund and E. Zschippang</i>	253
Electrochemical Reduction of Tantalum Compounds in Ambient Temperature Melts <i>Y. Furukawa, M. Morimitsu and M. Matsunaga</i>	263
Electrochemical Studies of Magnesium Deposition in Ionic Liquids <i>G. T. Cheek, W. O'Grady, S. Z. El Abedin, E. M. Moustafa and F. Endres</i>	269

Fabrication of Porous Metal Surfaces from a ZnCl ₂ -1-Ethyl-3-Methylimidazolium Chloride Ionic Liquid	281
<i>C. Tai, Y. Lin, F. Yeh, J. Huang and I. Sun</i>	
Electrodeposition of Cobalt from an Imide-Type Room-Temperature Ionic Liquid	287
<i>Y. Katayama, R. Fukui and T. Miura</i>	
The Bis((trifluoromethyl)sulfonyl)imide-Based Room Temperature Ionic Liquids Used for Several Electrochemical Applications	297
<i>M. Deng, C. Su, S. Hsu and P. Chen</i>	
Electrochemical Alloying of Copper Substrate with Tin Using Ionic Liquid as an Electrolyte at Medium-Low Temperatures	313
<i>K. Murase, R. Kurosaki, T. Katase, H. Sugimura, T. Hirato and Y. Awakura</i>	
Electrodeposition of Molybdenum in LiTFSI-CsTFSI Melt at 150°C	323
<i>B. Gao, T. Nohira and R. Hagiwara</i>	
Electrodeposition of Refractory Metals from Some ZnCl ₂ Based Molten Salts at 150-250°C	333
<i>T. Nohira, H. Nakajima, K. Kitagawa, R. Hagiwara, K. Nitta, S. Inazawa and K. Okada</i>	
Electrodeposition of Iron from Molten Mixed Chloride/Fluoride Electrolytes	341
<i>G. Haarberg, E. Kvalheim, S. Rolseth, T. Murakami, S. Pietrzyk and S. Wang</i>	
Direct Reduction of Vanadium Oxide in Molten CaCl ₂	347
<i>R. O. Suzuki and H. Ishikawa</i>	
Electrorefining of Silicon in Molten Calcium Chloride	357
<i>O. E. Kongstein, C. Wollan, S. Sultana and G. Haarberg</i>	
Phase Composition of the Cathodic Products Obtained in Alkali Chloride Melts Containing Potassium Monooxyfluoride Complexes of Tantalum	363
<i>V. Grinevitch, S. A. Kuznetsov, A. Arakcheeva and M. Gaune-Escard</i>	
Formation of Ni-Zr Alloys in Molten Fluorides	375
<i>H. Groult, A. Barhoum, H. El Ghallali, F. Lantelme and S. Borensztajn</i>	
Anodic Behaviors of Noble Metals in Eutectic LiCl-KCl Melt	385
<i>T. Takenaka and M. Kawakami</i>	
Effect of Production Methods on the Features of Sodium-Reduced Tantalum Powders	395
<i>V. N. Kolosov, M. Miroshnichenko, V. Orlov and T. Prokhorova</i>	

Electrodeposition of Tungsten, Molybdenum and Double Carbides of Tungsten (Molybdenum) and Nickel (Cobalt) from Low-Temperature Halide-Oxide Melts <i>H. B. Kushkhov and M. N. Adamokova</i>	399
Study of Causes of Film Formation on the Electrolyte Surface during Niobium Electrorefining <i>I. B. Polovov, M. V. Chernyshov, O. I. Rebrin, V. A. Volkovich, M. G. Shtutsa and T. R. Griffiths</i>	415
Codeposition of Silver with Tungsten Carbide in Tungstate Melts <i>V. Malyshev, A. Gab and M. Gaune-Escard</i>	423
Composition and Properties of Oxide Films on a Ferriti Steel and a Nickel-Based Alloy in Molten Hydroxide - Carbonate Electrolytes <i>T. B. Tzvetkoff and M. S. Bojinov</i>	429

Chapter 6 **Investigations of Lanthanides and Actinides in Molten Salts and Ionic Liquids**

Revival of Halide Salts as High-Temperature Heat-Transfer Media: Key Technical and Scientific Issues <i>D. F. Williams</i>	441
Thermodynamics and Transport Properties of the CeBr ₃ - MBr Binary Systems <i>M. Gaune-Escard, L. Rycerz, E. Ingier-Stocka and S. Gadzuric</i>	453
CEMSO (Catalyst Enhanced Molten Salt Oxidation) for Complete and Continuous Pyrochemical Reprocessing of Spent Nuclear Fuel: An Overview of a Viable New Technology for Next Generation Nuclear Reactors <i>T. R. Griffiths, V. A. Volkovich and W. R. Carper</i>	467
Study of Chlorine-Oxygen Exchange Reaction in NaCl-2CsCl <i>A. Osipenko and A. Mayorshin</i>	483
Behaviour of Rare Earth Elements in Molten Salts in Relation to Pyrochemical Reprocessing of Spent Nuclear Fuels <i>V. A. Volkovich, B. D. Vasin, T. R. Griffiths, I. B. Polovov, E. O. Medvedev and S. M. Yakimov</i>	493
Spectroelectrochemical Study of Uranium and Neptunium in LiCl-KCl Eutectic Melt <i>I. B. Polovov, C. A. Sharrad, I. May, B. D. Vasin, V. A. Volkovich and T. R. Griffiths</i>	503

Chapter 7
Electrochemistry and Properties of Molten Salts and Ionic Liquids

Thermal Cycling of Epoxy Coatings using Room Temperature Ionic Liquids <i>B. Hinderliter, K. Allahar, G. Bierwagen, D. E. Tallman and S. Croll</i>	515
Measurement and Thermodynamic Analysis of NiF ₂ /Ni Electrode Potential in a Dehydrated Melt of NH ₄ F·2HF <i>A. Tasaka, E. Morimoto, A. Mimoto, A. Inoue and M. Inaba</i>	529
Corrosion Behavior of the Electrochemical Couple: Hastelloy/Carbon Material in Zirconium Fluoride - Sodium Fluoride Melts <i>A. A. Omel'chuk, S. V. Volkov, B. M. Voronin, N. I. Buryak, A. A. Andriiko, A. S. Bakai and R. N. Savchuk</i>	543
Speciation of Molybdenum and Tungsten in Molten Chlorides: A Spectroelectrochemical Study <i>V. A. Volkovich, D. A. Danilov, I. B. Polovov, B. D. Vasin, T. R. Griffiths, D. E. Aleksandrov, O. A. Tropin and D. V. Tsarevskii</i>	555
Hydrogen Electrode Reaction in Some Imide-Type Room-Temperature Ionic Liquids <i>R. Fukuta, Y. Katayama and T. Miura</i>	567
Electrode Kinetics of Some Iron Complexes in an Imide-Type Room-Temperature Ionic Liquid <i>N. Tachikawa, Y. Katayama and T. Miura</i>	577
Thermodynamics of the Formation of Vanadium(II) Complexes in Chloride Melts <i>I. B. Polovov, B. D. Vasin, A. V. Abakumov, O. I. Rebrin, M. V. Chernyshov, V. A. Volkovich and T. R. Griffiths</i>	589
Electrochemical Behavior of Sulphur Species in Molten Chlorides <i>J. Hajasova, G. Haarberg and A. Martinez</i>	599
Electrochemical Studies of Fluorenone in Ionic Liquids and Aprotic Solvents <i>D. Canby and G. T. Cheek</i>	609
Author Index	613