Final Technical Report

Twelfth International Symposium on Molten Salts

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13. ABSTRACT *(Maximum 200 Words)*

The Twelfth International Symposium on Molten Salts was held during the 1999 Joint International Meeting in Honolulu Hawaii, October 17-22, 1999. This meeting served as the 196th Meeting of the Electrochemical Society and the 1999 Fall Meeting of the Electrochemical Society of Japan. The co-organizers of this symposium were Hugh C. De Long, United States Naval Academy; Paul C. Trulove, Air Force Office of Scientific Research; Gery R. Stafford, National Institute of Standards and Technology; and Shigehito Deki, Kobe University. Speakers came from over 15 different countries and well over two thirds of the papers presented were by authors from outside North America. The diversity of the topics covered by the papers presented at this symposium indicates the dynamic nature of molten salt research. This symposium continues to be a very popular venue for presentation of cutting edge research related to molten salts. Over 85 papers were presented on topics ranging from applications of room-temperature molten salts to theoretical investigations of molten salt structures.

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MOLTEN SALTS XII

Twelfth International Symposium on Molten Salts

(Physical Electrochemistry Division/High Temperature
Materials Division/Electrodeposition Division)

This symposium will provide an international and interdisciplinary forum centered on innovative basic and applied research performed in molten salts and ionic liquids. Contributed papers are solicited in all areas of chemistry, electrochemistry, electrochemical engineering, and physics related to molten salt research. Topics of interest include: 1. Electrochemical Power, e.g., batteries, fuel cells, capacitors, and photovoltaics; 2. Homogeneous and Heterogeneous Reactions, e.g., catalysis, inorganic and organic syntheses, oligomerizations, and polymerizations; 3. Electrodeposition, e.g., metal electrowinning, the deposition of alloys, semiconductors, intermetallics and layered structures, the structural characterization of electrodeposits, metalliding and surface modification, and characterization of electroactive species; 4. Separations, e.g., selective extractions, immobilized molten salt gas membranes, and electrochemical gas separations; 5. Molten Salt Promoted Corrosion Phenomena; 6. Solute and Solvent Structural Investigations; and 7. New Innovative Molten Salts and Molten Salt Mixtures, e.g., hydrophobic molten salts and molten salt mixtures, liquid clathrates, low vapor pressure (vacuum resistant) molten salts, air-insensitive molten salts.

Keynote lectures will be presented by invited speakers. Depending upon the number of papers received, a poster session may be planned. Student participation is highly encouraged, and it is anticipated that some funds will be available for student support. Publication of a Proceedings Volume is planned. Authors are required to provide a camera-ready copy of their paper in the correct format and a list of keywords at or before the Meeting. All papers will be reviewed for content.

Abstracts, suggestions, and inquiries should be sent to the ECS Headquarters Office and one of the Symposium Organizers: H. C. De Long, AFOSR/NL, 801 North Randolph Street, Room 732, Arlington VA, 22203-1977, USA, Phone: (202) 767-7761, Fax: (202) 404-7475, E-mail: hugh.delong@afosr.af.mil; S. Deki, Department of Chemical Science and Engineering, Faculty of Engineering, Kobe University, Rokkodai, Nada, Kobe 657, Japan, Phone: 81(78) 803-1155, Fax: 81 (78) 803-1169, E-mail: deki@icluna.kobe-u.ac.jp; D. A. Shores, Corrosion Research Center, University of Minnesota, 151 Admundson Hall, 221 Church St SE, RM 112, Minneapolis, MN 55455 USA, Phone: (612) 625-0014, Fax: (612) 626-7246, E-mail: dshores@marron.tc.umn.edu; G. R. Stafford, National Institute of Standards and Technology, Metallurgy Division, Building 224 B166, Gaithersburg, MD 20899 USA, Phone: (301) 975-6412, Fax: (301) 926-7679, E-mail: stafford@tiber.nist.gov; or P. C. Trulove, Department of Chemistry, United States Naval Academy, Annapolis, MD 21402 USA, Phone: (410) 293-6610, Fax: (410) 293-2218, E-mail: trulove@brass.nadn.navy.mil.

This symposium will provide an international and interdisciplinary forum centered on innovative basic and applied research performed in molten salts and ionic liquids. Contributed papers are solicited in all areas of chemistry, electrochemistry, electrochemical engineering, and physics related to molten salt research. Topics of interest include: 1. Electrochemical Power, *e.g.*, batteries, fuel cells, capacitors, and photovoltaics; 2. Homogeneous and Reactions, *e.g.*, catalysis, inorganic and organic syntheses, oligomerizations, and polymerizations; 3. Electrodeposition, *e.g.*, metal electrowinning, the deposition of alloys, semiconductors, intermetallics and layered structures, the structural characterization of electrodeposits, metalliding and surface modification, and characterization of electroactive species; 4. Separations, *e.g.*, selective extractions, immobilized molten salt gas membranes, and electrochemical gas separations; 5. Molten Salt Promoted Corrosion Phenomena; 6. Solute and Solvent Structural Investigations; and 7. New Innovative Molten Salt Mixtures.

Keynote lectures will be presented by invited speakers. Depending upon the number of papers received, a poster session may be planned. Student participation is highly encouraged, and it is anticipated that some funds will be available for student support.

A proceedings volume will be published. Authors are required to provide a camera-ready copy of their papers in the correct format and a list of keywords at or before the Meeting. All papers will be reviewed for content.

Abstracts, suggestions, and inquiries should be sent to the ECS Headquarters Office and the Symposium Organizers:

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1999 Joint International Meeting - Honolulu, Hawaii

October 17-22, 1999

Twelfth International Symposium on Molten Salts

Physical Electrochemistry Division/ Electrodeposition Division/ High Temperature Materials Division

Monday, October 18, 1999

Coral Ballroom I, Mid Pacific Conference Center

Room-Temperature Molten Salts

Co-Chairs: P.C. Trulove and H.C. DeLong

10:00 Opening Remarks

10:05 Buffered Chloroaluminate Melts and Latent Acidity - R. Osteryoung (North Carolina State University)

10:35 Heterogeneous Catalytic Hydrogenation with Supported Ionic Liquid Membranes - R. Carlin (Office of Naval Research), T. Cho (Worcester Academy), and J. Fuller (United States Air Force)

11:05 Ionic Liquid-Polymer Impregnated Nafion Electrolytes - J. Fuller (United States Air Force) and R. Carlin (Office of Naval Research)

11:25 Ioinic Liquid, Graphite nad Gel Polymer Electrolytes and Electrodes Using 1,2-dimethyl-3-propyl-imidazolium tetrafluoroborate. - T. Sutto (Naval Research Laboratory), H. De Long (Air Force Office of Scientific Research), and P. Trulove (U.S. Naval Acadmey)

11:45 Polymer Extractions by Room Temperature Chloroaluminate Molten Salts - J. Wilkes, P. Castle, C. Humphrey, F. Layo, and R. Slanger (US Air Force Academy)

Room-Temperature Molten Salts (cont'd)

Co-Chairs: H.C. DeLong and P.C. Trulove

1:30 Synthesis of Precursors to III-V Materials via Ambient Temperature Chloroaluminate Molten Salts - M.T. Carter, M.E. Berton, and K.L. Kies (Eltron Research, Inc.)

1:50 The Redox Chemistry of Plutonium in Room Temperature Ionic Liquids - D. Costa and W. Smith (Los Alamos National Laboratory)

2:10 Electrochemical Behavior of Lanthanum Ion in $LaCl_3$ Saturated $AlCl_3$-EMIC Room Temperature Molten Salts - T. Tsuda and Y. Ito (Kyoto University)

2:30 Electrochemical Behavior of Silver(I) in 1-ethyl-3-Methylimidazolium Tetrafluoroborate Prepared by a Novel Procedure - Y. Katayama, S. Dan, T. Miura, and T. Kishi (Keio University)

2:50 Electrochemical Reduction of Ta(V) in the $TaCl_5$-EMIC Low Temperature Molten Salt - M. Morimitsu, T. Matsuo, and M. Matsunaga (Kyushu Institute of Technology)

3:10 Thirty-Minute Intermission

3:40 Electrochemical Behavior of Vanadium(II / III) and Niobium(IV / V) in Basic 1-ethyl-3-methylimidazolium Chloride - Aluminum Trichloride Molten Salt - Y. Katayama, I. Konishiike, K. Shinozaki, T. Miura, and T. Kishi (Keio University)

4:00 Hydride Ion Behavior in Acidic Chloroaluminates at Ambient Temperature - D. Wassell, K. Johnson, and L. Mihichuk (University of Regina)

4:20 Reactions of Alkanes and Cycloalkanes in Ambient Temperature Ionic Liquids - M. Elrutb, K. Johnson, Y. Patell, and R. Simank (University of Regina)

4:40 Application of Ionic Liquids as Electrolytes in Lithium Rechargeable Cells - J. Caja, T.D.J. Dunstan (Electrochemical Systems, Inc.), D.M. Ryan (Wright-Patterson AFB), and V. Katovic (Wright State University)

5:00 Transition Metal Centered Reactions in Ambient-Temperature Ionic Liquids - T. Welton, T. Welton, G.B. Young, and P. Dyson (Imperial College)

Tuesday, October 19, 1999

Room-Temperature Molten Salts (cont'd)

Co-Chairs: M.T. Carter and J.S. Wilkes

8:00 Opening Remarks

8:05 Studies of Cation Transport in Molten Salts and Molten Salt-Polymer Gels by Pulsed-Field-Gradient Spin-Echo NMR - P. Trulove (US Naval Academy), R. Mantz (AFRL/PRSF), H. De Long (Air Force Office of Scientific Research), and R. Osteryoung (North Carolina State University)

8:25 The Density and HNMR Spectra of Binary Solution of N-methylpyrdinium Iodine and N-Methylpyridinium Chloride - D.S. Newman, D.Y. Chen, and C. Silkowski (Bowling Green State University)

8:45 Improvement of Ionic Conductivity of Room Temperature Molten Salt Based on Quaternary Ammonium Cation and Imide Anion - H. Matsumoto, M. Yanagida, K. Tanimoto, T. Kojima, Y. Tamiya, and Y. Miyazaki (Osaka National Research Institute)

9:05 Low Temperature Molten Viologens-Phase Transition and Electrochemical Properties- - K. Ito Akita and H. Ohno (Tokyo University of Agri. and Tech.)

9:25 Electrochemical Properties of Room Temperature Molten Salts with Tetrafluoroborate Anion - A. Noda and M. Watanabe (Yokohama National University)

9:45 Coffee Break in the Exhibit Hall

10:15 Structure and Bonding in Ionic Liquids - A. Carmichael, C. Hardacre, J. Holbrey, K. Seddon, and M. Nieuwenhuyzen (The QUILL Centre)

10:35 Structural Characteristics of Imidazolium Ionic Liquids: The non-Haloalmuinates - A. McEwen (Covalent Associates, Inc.)

Structural Investigations of Molten Salts

Co-Chairs: J.S. Wilkes and M.T. Carter

10:55 Structural and Redox Properties of Vanadium Complexes in Molten Salts of Interest for the Catalytic Oxidation of Sulfur Dioxide - S. Boghosian, A. Chrisanthopoulos, and R. Fermann (Forth-ICE/HT)

11:20 Structural Analysis of Molten Rare Earth Halides by EXAFS - Y. Okamoto, H. Motohashi, M. Akabori, and T. Ogawa (Japan Atomic Energy Research Institute)

11:40 Influence of External Electromagnetic Fields on the Structure and Diffusion Properties of Molten Salts - P. Zilberman, A. Chernikov, V. Znamensky, and V. Rogov (Institute of Informatics and Problems of Regional Development)

Structural Investigations of Molten Salts (cont'd)

Co-Chairs: S. Deki and M.-L. Saboungi

1:30 Towards an Understanding of Ionic Transport in Lithium Conducting Polymers - M.-L. Saboungi, G. Mao (Argonne National Laboratory), H. Fischer (ILL), W.S. Howells (ISIS), and D.L. Price (Argonne National Laboratory)

1:50 Computational Studies of Lithium Polymer Electrolytes - L. Curtiss and A. Baboul (Argonne National Laboratory)

2:10 The Reverse Monte Carlo Studies of Molten Alkali Carbonates - S. Kohara (Japan Synchrotron Radiation Research Institute), K. Suzuya, and H. Ohno (Japan Atomic Energy Research Institute)

2:30 **CANCELLED** Molecular Dynamics Modelling of Microstructure and Counterion Transport in Ionic Polymers - J. Clarke, C. Wong, and M. Banaszak (UMIST)

2:50 Structure of the MF-AlF_3-Al_2O_3(M=Li, Na, K) Melts - T. Ostvold, O.T. Gustavsen, and V. Danek (Slovak Academy of Sciences)

3:10 Thirty-Minute Intermission

Thermodynamic Studies in Molten Salts

Co-Chairs: M.-L. Sabounji and S. Deki

3:40 Electrical Conductivity and Melting Behavior of Inorganic Powder/Alkali-metal Carbonate Coexisting Systems - S. Deki, G. Cha, Y. Harada, M. Mizuhata, and A. Kajinami (Kobe University)

4:10 Concept of Mismatch and Relaxation Explains DC and AC Conductivities of Fragile Glass Forming Ionic Melts - K. Funke, B. Heimann, M. Vering, and D. Wilmer (Institut fuer Physikalische Chemie)

4:30 Density and Electrical Conductivity of Molten $MgCl_2$-$CaCl_2$ Binary Melt - Y. Sato, Y. Kuroda, T. Nagatsu, M. Hoshi, J.-I. Kim, and T. Yamamura (Tohoku University)

4:50 Chemical and Electrochemical Studies in Molten Carbnates Containing Silica - S. Devyatkin, A. Pisanenko, and V. Shapoval (INOC)

Wednesday, October 20, 1999

Thermodynamic Studies in Molten Salts (cont'd)

Co-Chairs: M. Gaune-Escard and A.K. Adya

10:00 Opening Remarks

10:05 Phase Diagram and Surface Tension of the System LiF-KF-K_2NbF_7 - M. Chrenkova, D.K. Nguyen, V. Danek, and A. Silny (Slovak Academy of Sciences)

10:30 Electrochemical Thermodynamic Estimation of M-H System in LiCl-KCl-LiH Melts - T. Nishikiori, T. Nohira, and Y. Ito (Kyoto University)

10:50 Salt-Amide Supercooled Mixtures - G. Berchiesi (Universita Camerino)

11:10 Thermodynamic Properties of Solid and Liquid LnCl3 and LnCl3-MCl Systems (Ln=Lanthanide ;M= Alkali) - M. Gaune-Escard and L. Rycerz (Universite de Provence)

11:30 Structural and Thermodynamic Properties of Molten UCl_3 and UCl_3-MCl (M = Li, Na, K and Cs) Systems - A. Adya, H. Matsuura (University of Abertay Dundee), R. Takagi (Tokyo Institute of Technology), L. Rycerz (Technical University of Wroclaw), and M. Gaune-Escard (IUSTI)

11:50 Study of Bicomponent Molten Salts by the Contact Melting Method - P. Zilberman, A. Chernikov, V. Znamensky, E. Goncharenko, and Y. Skaev (Institute of Informatics and Problems of Regional Development)

High Temperature Molten Salts

Co-Chairs: Y. Ito and T.R. Griffiths

1:30 Thin Film Hot Corrosion Studies of Oxidised and Carburized Type 310 Stainless Steel - T. Griffiths (The University of Leeds) and N. Phillips (T.R Oil Services Ltd.)

1:55 Electrochemical Behavior of Hydride Ion and Deuteride Ion in Molten Fluoride Systems - H. Qiao, T. Nohira, and Y. Ito (Kyoto University)

2:15 Electrochemical Reactions of Si and Evolution of SiH_4 in Molten Alkali Halide Systems - T. Nohira and Y. Ito (Kyoto University)

2:35 Study of the Anode Process on Carbon Electrodes in the Pure Magnesium Chloride Melt with Dissolved Magnesium Oxide at 1023K - M. Mohamedi (Tohoku University), B. Borresen, G.-M. Haarberg, and R. Tunold (NTNU)

2:55 Thirty-Minute Intermission

3:25 The Solubility of NiO and $NiAl_2O_4$ in Cryolite Melts - O.-A. Lorentsen (Norwegian University of Science and Technology), E.W. Dewing (Retired), and J. Thonstad (Norwegian University of Science and Technology)

3:45 A Novel Sensitive Method for Determining Oxygen Solubility in Molten Carbonates and Carbonate-Containing Melts: Reaction of Oxidising Species Formed with Uranium Dioxide - V. Volkovich, T. Griffiths (University of Leeds), D. Fray (University of Cambridge), M. Fields, and R. Thied (British Nuclear Fuels Plc.)

4:05 Performance of Li-Alloy/Ag_2CrO_4 Couples in Molten CsBr-LiBr-KBr Eutectic - R. Guidotti and F. Reinhardt (Sandia National Laboratories)

4:25 Internal Cation Mobilities in the Ternary Molten System (Na,K, Cs)Cl - M. Matsumiya and R. Takagi (Japan Atomic Energy Research Institute)

4:45 The Solubility of FeO and $FeAl_2O_4$ in Cryolite Melts - T.E. Jentoftsen (Norwegian University of Science and Technology), E.W. Dewing (Consultant), G.M. Haarberg (SINTEF Materials Technology), and J. Thonstad (Norwegian University of Science and Technology)

Max Bredig Award Banquet

Co-Chairs: S. Deki and H.C. DeLong

7:00 **PHYSICAL ELECTROCHEMISTRY DIVISION MAX BREDIG AWARD ADDRESS**-Selected Topics of Molten Salt Electrochemistry - Y. Ito (Kyoto University)

Thursday, October 21, 1999

Electrodeposition in Molten Salts

Co-Chairs: G.R. Stafford and C.L. Hussey

8:00 Opening Remarks

8:05 Electrodeposition of Silver-Aluminum Alloys from Room-Temperature Chloroaluminate Molten Salts - C.L. Hussey and Q. Zhu (University of Mississippi)

8:30 Electrodeposition of Cu-Zn Alloys from a Lewis Acidic Zinc Chloride-1-Ethyl-3-methylimidazolium Chloride Molten Salt - P.-Y. Chen, M.-C. Lin, and I.-W. Sun (National Cheng-Kung University)

8:50 Electrodeposition and Pitting Corrosion of Aluminum-Manganese Alloys from Room Temperature Chloroaluminate Molten Salts - H. De Long (Air Force Office of Scientific Research) and J. Mitchell (Naval Research Laboratory)

9:10 Electrodeposition of Niobium and Tantalum from a Room-Temperature Molten Salt - G.T. Cheek, P.C. Trulove (United States Naval Academy), and H.C. De Long (Air Force Office of Scientific Research)

9:30 Coffee Break in the Exhibit Hall

10:00 The Electrodeposition of Al-Cu Alloys from Room-Temperature Chloroaluminate Electrolytes - G. Stafford, V. Jovic (NIST), Q. Zhu, S. Jones, and C. Hussey (University of Mississippi)

10:20 Electrodeposition and Dissolution of Nb and Al in Molten Chloride Bath - N. Kawaguchi, N. Maeda, Y. Sato, and T. Yamamura (Tohoku University)

10:40 Electrochemical Behaviour of Dissolved Niobium, Molybdenum and Tantalum Species in Molten Chloroaluminates - G.M. Haarberg (SINTEF Materials Technology) and G. Stafford (National Institute of Standards and Technology)

11:00 Electrodeposition of Tungsten in a Basic $ZnCl_2$-NaCl (40-60 mol%) Melt - A. Katagiri and H. Takenishi (Kyoto University)

11:20 Direct Electrowinning of Liquid Titanium Metal Using by Direct Current Electro Slag Remelting Apparatus - T. Takenaka, M. Ishikawa, and M. Kawakami (Toyohashi University)

11:40 The Electrodeposition of Titanium from the Low Temperature Molten Electrolytes - H.-Y. Hsu, D.-L. Chen, H.-W. Tsao, and C.-C. Yang (National Yunlin University of Science and Technology)

Electrodeposition in Molten Salts (cont'd)

Co-Chairs: E.G. Polyakov and G.M. Haarberg

1:30 A Voltammetric Study of Titanium Electrorefining in Chlorotitanate Melts - L. Ortiz and D. Sadoway (Massachusetts Institute of Technology)

1:50 Nucleation and Diffusion Controlled Growth of Lead, Zinc and Magnesium from LiCl-KCl Eutectic Melt - T. Store (Hydro Aluminium), G.M. Haarberg, and R. Tunold (Norwegian University of Science and Technology)

2:10 Lower Oxidation State Niobium Oxofluoride Compounds: Possiblity of Existence in Melts and Part in Electrochemical Processes - V.V. Grinevitch, A.V. Arakcheeva, V.A. Reznichenko (Russian Academy of Sciences), S.A. Kuznetsov (Russian Academy of Science), A.F. Vik, and T. Ostvold (University of Trondheim)

2:30 Titanium, Boron, and Titanium Diboride Deposition in Alkali Fluorochloride Melts - M. Chemla, F. Lantelme, A. Barhoun (UPMC), and J. von Barner (DTU)

Coral Lounge, Mid Pacific Conference Center

Poster Session (2:50 PM - 5:30 PM)

Co-Chairs: G.R. Stafford and P.C. Trulove

2:50 Authors may begin setting up their posters at 2:00 P.M.

- **CANCELLED** Local Structures in Molten Aluminium - Alkali Fluorides - Z. Akdeniz, Z. Cicek, A. Karaman (University of Istanbul), and M.P. Tosi (Scuola Normale Superiore)
- Electrodeposition of Metals from Molten Salts - A.M. Martinez Cuellar, G.M. Haarberg (Norwegian University of Science and Technology), Y. Castrillejo (Universidad de Valladolid), B. Borresen, and R. Tunold (Norwegian University of Science and Technology)
- Electrochemical Epitaxial Growth of Diamonds in Ionic Melts - A. Gab, I. Novoselova, and V. Shapoval (Ukrainian Academy of Science)
- Electrodeposition of Lanthanum and La-Ni Alloys by Molten Salts Electrolysis - C. Dias and E.J. Pessine (Institute of Energy and Nuclear Research - IPEN)
- **CANCELLED** Solubility of Alumina in Hydroxide-Salts Melts - O. Zarubitskii and I. Skryptun (V.I.Vernadskii Institute of General and Inorganic Chemistry)
- Temperature Dependence of Thermal Conductivity in Molten Alkali Metal Halides by MD Simulation - K. Takase, I. Akiyama, and N. Ohtori (Niigata University)
- Electrical Conductivity and Nuclear Magnetic Resonance of Molten Lithium Borates - T. Katsumata, N. Suzuki, M. Shibasaki, and T. Matsuo (Toyo University)
- Niobium Fluorocomplexes and Oxyfluorocomplexes in Fluoride Melts - V. Van, A. Silny, and V. Danek (Slovak Academy of Sciences)
- The Variation of Structure with Composition for Mixed Molten Hydrate - A. Kajinami, S. Deki, M. Mizuhata, and M. Kubota (Kobe University)
- Large Scale Molecular Dynamics Simulations for Molten Salts - Y. Okamoto, S. Ishizuki, and T. Ogawa (Japan Atomic Energy Research Institute)
- Raman Spectra of K_2O-B_2O_3 Glasses and Melts - R. Akagi (Kobe University), N. Ohtori (Niigata University), and N. Umesaki (AIST)
- Electrochemical Studies of Metal Dichalcogenide-Polymer Composite Electrodes in 1,2-dimethyl-3-propyl-imidazolium tetrafluoroborate and 1-ethyl-3-methyl-imidazolium tetrafluoroborate - T. Sutto (Naval Research Laboratory), H. De Long (Air Force Office of Scientific Research), and P. Trulove (U. S. Naval Academy)
- Electrochemical Intercalation Studies of 1,2-dimethyl-3-propyl-imidazolium tetrafluoroborate and 1-ethyl-3-methyl-imidazolium tetrafluoroborate in Graphite and

Graphite-Polymer Composite Electrodes - T. Sutto, C. Sienerth (Naval Research Laboratory), H. De Long (Air Force Office of Scientific Research), and P. Trulove (U. S. Naval Academy)

- Alumina Sensors in Hall-Heroult Electrolyte. - S. Rolseth, H. Gudbrandsen, and G.M. Haarberg (SINTEF Materials Technology)

- The Catalytic Effect of a PT Electrode Surface on the Electrodeposition of Boron in Molten Flinak - G. Ett and E. Jorge Pessine (Institute of Energy and Nuclear Research - IPEN)

Friday, October 22, 1999

Coral Ballroom I, Mid Pacific Conference Center

Electrodeposition in Molten Salts (cont'd)

Co-Chairs: Y. Ito and S. Rolseth

8:00 Opening Remarks

8:05 Electrode Reactions of Borides of Refractory Metals in Fluoroborate Melt - M. Kawakami, T. Takenaka, and K. Nagao (Toyohashi University)

8:25 The Catalytic Effect of a Platinum of a Platinum Working Electrode on the Electrodeposition Potential of Boron - G. Ett and E.J. Pessine (Institute of Energy and Nuclear Research - IPEN)

8:45 The Effect of the Melt Composition on Electrode Processes and Structure of Tantalum-Boride Coatings - O. Makarova, L. Polyakova, E. Polyakov, A. Shevyryov (RAS), and N. Bjerrum (Technical University of Denmark)

9:05 Formation of Nitiride Thin Films by Electrochemical Implantation - T. Goto and Y. Ito (Kyoto University)

9:25 Potential Response During the Alloying Process after Molten Salts Electrolysis - H. Yamamoto, K. Kuroda, R. Ichino, and M. Okido (Nagoya University)

9:45 The Electrode Processes of Y (III) on Copper Nickel Aluminum Electrodes and Surface Metalliding in Molten Salts - S. Duan (University of Science and Technology Beijing) and G. Jin (Tsinghua University)

10:05 Coffee Break in the Exhibit hall

Technological Applications of Molten Salts

Co-Chairs: R.A. Mantz and G.T. Cheek

10:35 Molten Salt Membrane Process for Chlorine Recovery - J. Johnson and J. Winnick (Georgia Institute of Technology)

11:00 Electrolytic Recovery of Molten Pulping Chemicals: An Alternative to the Kraft Causticizing Process - R. Wartena, J. Winnick (Georgia Institute of Technology), and P. Pfromm (Institute of Paper Science and Technology)

11:20 Electrochemical Flue Gas Cleaning using Molten Pyrosulfate-Based Membranes - S.B. Rasmussen, M. Eriksen, R. Fehrmann (Technical University of Denmark), and J. Winnick (Georgia Institute of Technology)

11:40 Electrochemical Promotion of Sulfur Dioxide Catalytic Oxidation - I. Petrushina (Technical University of Denmark), V. Bandur (V.I Vernaskii Institute of General and Inorganic Chemistry, National Academy of Sciences of Ukraine), F. Cappeln, and N. Bjerrum (Technical University of Denmark)

Technological Applications of Molten Salts (cont'd)

Co-Chairs: G.T. Cheek and R.A. Mantz

1:30 Determination of Gas Permeability of Molten Salts and Slaq Adequate Medium - T. El Gammal and W.-H. Chung (Institute for Ferrous Metallurgy (IEHK))

1:50 Characterization of the LiSi/CsBr-LiBr-KBr/FeS_2 System for Potential Use as a Geothermal Borehole Power Source - R. Guidotti and F. Reinhardt (Sandia National Laboratories)

2:10 Development of a High Power Zebra Battery - J. Prakash (Illinois Institute of Technology)

2:30 Cell Efficiency in Bipolar Electrode Cell for Aluminum Electrorefining - M. Ueda, T. Ohmura, S. Konda, T. Sasaki, and T. Ohtsuka (Hokkaido University)

2:50 Electrolytic Production of Nitrogen Trifluoride with a Nickel Based Composite Electrode Prepared by HIP - A. Tasaka, T. Makino, Y. Suzuki, T. Maeda, K. Takao, T. Ueno, H. Takemura, and O. Yamaguchi (Doshisha University)

3:10 High Temperature Electrochemical Heat Pump Using Water Gas Shift Reaction-Electrolytic Reduction of Carbon Dioxide in Molten Carbonate - A. Ishihara, T. Fujimori, N. Motohira, K.-I. Ota, and N. Kamiya (Yokohama National University)

PREFACE

The Twelfth International Symposium on Molten Salts was held during the 1999 Joint International Meeting in Honolulu Hawaii, October 17-22, 1999. This meeting served as the 196th Meeting of the Electrochemical Society and the 1999 Fall Meeting of the Electrochemical Society of Japan. The Molten Salt Symposium was a resounding success due in no small part to the generous financial support of the Physical Electrochemistry, High Temperature Materials, and Electrodeposition Divisions of the Society. In addition, the Air Force Office of Scientific Research and the European Office of Aerospace Research and Development provided much needed funds to support the travel and registration of speakers for this symposium. The co-organizers of this symposium were Hugh C. De Long, United States Naval Academy; Paul C. Trulove, Air Force Office of Scientific Research; Gery R. Stafford, National Institute of Standards and Technology; and Shigehito Deki, Kobe University.

As in past years, this version of the molten salt symposium was truly an international affair. Speakers came from over 15 different countries and well over two thirds of the papers presented were by authors from outside North America. The diversity of the topics covered by the papers presented at this symposium indicates the dynamic nature of molten salt research. This symposium continues to be a very popular venue for presentation of cutting edge research related to molten salts. Over 85 papers were presented on topics ranging from applications of room-temperature molten salts to theoretical investigations of molten salt structures. The large number of papers presented at this symposium indicates the continued healthy state of molten salt research. The 1999 recipient of the Max Bredig Award was Professor Yasuhiko Ito of Kyoto University. In his award address, Professor Ito gave the audience a wry look back at his many years of molten salt research and the numerous colleagues who helped him along the way.

The editors wish to thank Prof. Trevor Griffiths, Prof. Graham Cheek, Prof. David Newman, and Dr. Robert Mantz for their much needed assistance in the review of articles for this proceedings. Furthermore, we wish to give a special thanks to Dr. Thomas Sutto for his many contributions to the organization and review of the proceedings. Finally, we would like to thank the U.S. Naval Academy, Department of Chemistry for their assistance with the numerous mailings required to get this symposium up and running.

Paul C. Trulove
AFOSR
January 2000

Dr. Yasuhiko Ito

Recipient of the 1999 Max Bredig Award

Dr. Yasuhiko Ito is Professor and Dean of the Graduate School of Energy Science at Kyoto University, Japan. He received his Bachelors of Science in 1963, his Masters of Science in 1965, and his Doctorate in 1969, all from Kyoto University. While still involved in his graduate work, Dr. Ito joined the staff of the Department of Industrial Chemistry at Kyoto University in 1968 as a research associate. After completing his gradate work, Dr. Ito left Kyoto University in September of 1969 to carry out a year long post-doctoral fellowship under the direction of Prof. Ibl at ETH in Zurich. Upon completion of his post-doctoral fellowship, Dr. Ito returned to his position at Kyoto University. He was subsequently promoted in 1971 to associate professor in the College of Liberal Arts and Sciences. In 1981, Dr. Ito moved to the Department of Nuclear Engineering at Kyoto University where, in 1989, he achieved the rank of professor. In 1996, Dr. Ito moved to the Graduate School of Energy Science at Kyoto University where he is currently the Dean.

Dr. Ito has published extensively in the area of molten salts. His often-cited research spans the entire range of molten salt chemistry. This includes molten salt electrochemistry, transport phenomena, chemical production processes, energy conversion processes, materials tailoring, and many others. Dr. Ito's current area of research focuses on processes and materials relating to converting solar, atomic, and chemical energies. His group is currently working on molten salts as a new energy medium, the inorganic synthesis of various nonaqueous systems, and electrochemical implantation for the preparation of functional materials.

Dr. Ito is an active member of The Electrochemical Society and has organized several international symposia, workshops, and conferences. Currently, Dr. Ito is chairman of the Molten Salts Committee of the Electrochemical Society of Japan. He is serving as an editor for the molten salt journal *Plasma and Ions,* and he is on the editorial boards for both *Electrochimica Acta* and *The Journal of Power Sources.*

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