

# SYMPOSIUM ES3

Materials for Multivalent Electrochemical Energy Storage  
April 18 - April 20, 2017

## Symposium Organizers

Veronica Augustyn, North Carolina State University  
Doron Aurbach, Bar-Ilan University  
Y. Shirley Meng, University of California, San Diego  
Naoaki Yabuuchi, Tokyo Denki University

## Symposium Support

Bio-Logic USA  
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## Proceedings Statement

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\* Invited Paper

SESSION ES3.1: High-Capacity Li Intercalation  
Session Chairs: Valerie Pralong and M Stanley Whittingham  
Tuesday Afternoon, April 18, 2017  
PCC North, 200 Level, Room 226 A

### 1:30 PM \*ES3.1.01

**Multi-Electron Cathodes—Two Li vs One Mg Intercalation Using Ti and V Model Compounds** M Stanley Whittingham; Binghamton University, United States.

### 2:00 PM ES3.1.02

**Comparative Ab Initio Study of Li, Na, Mg and Al Insertion in Vanadium Pentoxides and Dioxides** Sergei Manzhos; National University of Singapore, Singapore.

### 2:15 PM \*ES3.1.03

**Design of Materials with Original Structures, Ionic Conducting Properties Materials for Energy Storage** Valerie Pralong; CNRS CRISMAT, France.

### 2:45 PM ES3.1.04

**Structure and Electrochemistry of Transition Metal Substituted e-VOPO<sub>4</sub>** Carrie Siu; Binghamton University, United States.

### 3:00 PM BREAK

SESSION ES3.2: High-Capacity Intercalation  
Session Chairs: Ismael Saadoun and Naoaki Yabuuchi  
Tuesday Afternoon, April 18, 2017  
PCC North, 200 Level, Room 226 A

### 3:30 PM \*ES3.2.01

**Na<sub>2/3</sub>Co<sub>1-x</sub>Mn<sub>2x/3</sub>Ni<sub>x/3</sub>O<sub>2</sub> (x=0, 2/3, 1/2, 1/3, 1) Layered Oxides as Good Cathode Materials for Sodium-Ion Batteries** Saadoun Ismael; Universitè Cadi Ayyad, Morocco.

### 4:00 PM ES3.2.02

**Room-Temperature Na–CuCl<sub>2</sub> Rechargeable Battery Using SO<sub>2</sub>-Based Non-Flammable Inorganic Liquid Electrolyte** Ayoung Kim; Hanyang University, Korea (the Republic of).

### 4:15 PM ES3.2.03

**Bimetallic Dodecaborate LiNaB<sub>12</sub>H<sub>12</sub> and Its Application in All-Solid-State Batteries** Liqing He; South University of Science and Technology of China, China.

### 4:30 PM ES3.2.04

**DFT Study on the Li Mobility in Li-Ion-Based Solid-State Electrolytes** Md Shafiqul Islam; Missouri State University, United States.

### 4:45 PM ES3.2.05

**Synthesis and Optimization of High Energy Cathode Material LiVOPO<sub>4</sub> with Enhanced Electronic and Ionic Conductivity** Yong Shi; Binghamton University, United States.

SESSION ES3.3: Poster Session  
Tuesday Afternoon, April 18, 2017  
8:00 PM - 10:00 PM  
Sheraton, Third Level, Phoenix Ballroom

### ES3.3.01

**Commercial Graphite Surface Modified by Lithium Titanate for the Research of Lithium Ion Battery in Fast Charge/Discharge Application** Lung-Hao Hu; Southern Taiwan University of Science and Technology, Taiwan.

### ES3.3.02

**Facile Synthesis of Novel Interconnected Nanosheets Structure of Nickel Hydroxide and Copper for High-Performance Supercapacitor Application** Diwen Shi; National University of Singapore, Singapore.

### ES3.3.03

**Hydrated WO<sub>3</sub> for High Power and High-Volumetric Capacitance Electrochemical Capacitors** James B. Mitchell; North Carolina State University, United States.

### ES3.3.04

**Intercalation Mechanisms of Manganese-Rich Layered Sodium Oxides in Aqueous Electrolytes** Shelby Boyd; North Carolina State University, United States.

### ES3.3.05

**A High Single Ion Conductor Based on Mesoporous Silica-Polymer Nanohybrids for Lithium Ion Batteries** Youngdo Kim; Korea Institute of Materials Science, Korea (the Republic of).

### ES3.3.06

**MetILs<sup>3</sup>—A Strategy for Maximizing Energy Density in Flow Battery Electrolytes** Leo J. Small; Sandia National Laboratories, United States.

SESSION ES3.4: Mg Intercalation  
Session Chairs: Yury Gogotsi and Kisuk Kang  
Wednesday Morning, April 19, 2017  
PCC North, 200 Level, Room 226 A

### 8:00 AM \*ES3.4.01

**The Mg-Ion Storage Capability of MXenes** Yury Gogotsi; Drexel University, United States.

### 8:30 AM ES3.4.02

**Controlling Interlayer Interactions in Vanadium Pentoxide-Poly(ethylene oxide) Nanocomposites for Enhanced Magnesium-Ion Charge Transport and Storage** Christopher Rhodes; Texas State University, United States.

### 8:45 AM ES3.4.03

**First-Principles Design of Cathode Materials for Mg Batteries—The Role of Anion Doping and Nanostructuring** Liwen Wan; Lawrence Berkeley National Lab, United States.

### 9:00 AM \*ES3.4.04

**Activating Layered LiNi<sub>0.5</sub>Co<sub>0.2</sub>Mn<sub>0.3</sub>O<sub>2</sub> as a Host for Mg Intercalation in Rechargeable Mg Batteries** Kisuk Kang; Seoul National University, Korea (the Republic of).

9:30 AM ES3.4.05

**Systematic Electron Microscopy Study Investigating Mg Intercalation of Tunnel Structured  $\zeta$ - $V_2O_5$  Polymorph** [Arijita Mukherjee](#); University of Illinois at Chicago, United States.

9:45 AM BREAK

SESSION ES3.5: Mg Ion Batteries I

Session Chairs: Jordi Cabana and Rana Mohtadi  
Wednesday Morning, April 19, 2017  
PCC North, 200 Level, Room 226 A

10:15 AM \*ES3.5.01

**Rechargeable Magnesium Batteries—Advancements and Bottlenecks** [Rana Mohtadi](#); Toyota, United States.

10:45 AM ES3.5.02

**Electrochemical Stability of Magnesium-Based Anodes for Batteries** [Jodie A. Yuwono](#); Monash University, Australia.

11:00 AM ES3.5.03

**Nanostructure Cathode and Anode Materials for Mg-Ion Batteries** [Kostiantyn Kravchyk](#)<sup>1,2</sup>; <sup>1</sup>ETH Zurich, Laboratory of Inorganic Chemistry, Switzerland; <sup>2</sup>Empa - Swiss Federal Laboratories for Materials Science and Technology, Switzerland.

11:15 AM \*ES3.5.04

**Are Spinel Oxides Viable for the Reversible Intercalation of Divalent Ions? An Update** [Jordi Cabana](#); University of Illinois at Chicago, United States.

SESSION ES3.6: Mg Ion Batteries II

Session Chairs: Veronica Augustyn and Maximilian Fichtner  
Wednesday Afternoon, April 19, 2017  
PCC North, 200 Level, Room 226 A

1:45 PM \*ES3.6.01

**Magnesium Sulfur Battery—Its Beginning and Recent Progress** [Maximilian Fichtner](#); Helmholtz Institute Ulm (HIU), Germany.

2:15 PM ES3.6.02

**Multivalent Metal/Sulfur Chemistries for High Energy Density Rechargeable Battery** [Tao Gao](#); University of Maryland, United States.

2:30 PM BREAK

SESSION ES3.7: Anion Redox

Session Chairs: Alexis Grimaud and Naoaki Yabuuchi  
Wednesday Afternoon, April 19, 2017  
PCC North, 200 Level, Room 226 A

3:30 PM \*ES3.7.01

**Anionic Redox Processes for Energy Storage—Mastering the O-O Bond Formation** [Alexis Grimaud](#)<sup>1,2</sup>; <sup>1</sup>College de France, France; <sup>2</sup>Centre National de la Recherche Scientifique, France.

4:00 PM ES3.7.02

**A Joint Experimental and Theoretical Approach to the Question of Anion Redox in Lithium-Rich Layered Oxides** [William Gent](#)<sup>1,2</sup>; <sup>1</sup>Stanford University, United States; <sup>2</sup>Lawrence Berkeley National Laboratory, United States.

4:15 PM ES3.7.03

**Strong Oxygen Participation in the Redox Governing the Structural and Electrochemical Properties of Na-Rich Layered Oxide  $Na_2IrO_3$**  [Arnaud J. Perez](#)<sup>1,2</sup>; <sup>1</sup>Collège de France, France; <sup>2</sup>Sorbonne Universités, France.

4:30 PM ES3.7.04

**An Intermediate Temperature Solid Oxide Iron-Air Redox Battery Operated on  $O^{2-}$ -Chemistry and Loaded with Pd-Catalyzed Iron-Based Energy Storage Material** [Kevin Huang](#); University of South Carolina, United States.

4:45 PM ES3.7.05

**Regenerative Hydrogen Electrodes for Energy Storage** [Sanjeev Mukerjee](#); Northeastern University, United States.

SESSION ES3.8: Multivalent Chemistry Mg and Beyond

Session Chairs: Brian Ingram, Arumugam Manthiram, M. Rosa Palacin and Yan Yao  
Thursday Morning, April 20, 2017  
PCC North, 200 Level, Room 226 A

8:00 AM \*ES3.8.01

**On the Road towards Ca-Based Batteries** [M. Rosa Palacin](#); ICMAB CSIC, Spain.

8:30 AM ES3.8.02

**Rechargeable Al-Ion Battery in Ionic Liquid Electrolytes—Toward Multivalent Ion Secondary Batteries** [Hyunjung Shin](#); Sungkyunkwan University, Korea (the Republic of).

8:45 AM ES3.8.03

**Synthesis and Electrochemical Characterization of Anhydrous and Hydrated  $WO_3$  for Mg-Ion Intercalation in Non-Aqueous Electrolytes** [Ruocun Wang](#); North Carolina State University, United States.

9:00 AM \*ES3.8.04

**Multivalent Ions as the Next Energy Storage Frontier** [Brian J. Ingram](#); Argonne National Laboratory, United States.

9:30 AM BREAK

10:00 AM \*ES3.8.05

**Assessing the Practicality of Multi-Valent-Ion Insertion/Extraction into Hosts by Chemical Methods** [Arumugam Manthiram](#); University of Texas at Austin, United States.

10:30 AM ES3.8.06

**Two-Dimensional Vanadium Carbide (MXene) as a High Capacity Cathode Material for Rechargeable Aluminum Batteries** [Majid Beidaghi](#); Auburn University, United States.

10:45 AM \*ES3.8.07

**Development of Cathode Materials for Rechargeable Magnesium Batteries** [Yan Yao](#)<sup>1,2</sup>; <sup>1</sup>University of Houston, United States; <sup>2</sup>TcSUH, United States.

11:15 AM \*ES3.8.08

**Probing Efficient Mg Metal Electrodeposition and Dissolution with Weakly Coordinated Anions** [Kevin R. Zavadil](#); Sandia National Labs, United States.

11:45 AM ES3.8.09

**Nano-Sized Titanium Sulfide as Cathode Materials for Rechargeable Aluminum Ion Battery** [Linxiao Geng](#); University of California, Riverside, United States.

SESSION ES3.9: Electrochemical Capacitors

Session Chairs: Veronica Augustyn, Majid Beidaghi, Chunxu Pan and Christopher Rhodes  
Thursday Afternoon, April 20, 2017  
PCC North, 200 Level, Room 226 A

1:30 PM ES3.9.01

**Facet Dependent Electrochemical Behavior of  $\beta$ - $MnO_2$  Nanowires and Micro-Rods** [Wentao Yao](#); Michigan Technological University, United States.

1:45 PM ES3.9.02

**Tuning the Interlayer of Transition Metal Oxides for High Rate and Multivalent Energy Storage** [Veronica Augustyn](#); North Carolina State University, United States.

2:00 PM ES3.9.03

**Titanium Disulfide-Carbon Nanotube Electrodes Enable High Energy Density Pseudocapacitors** [Xining Zang](#)<sup>1,2</sup>; <sup>1</sup>University of California, Berkeley, United States; <sup>2</sup>University of California, Berkeley, United States.

2:15 PM ES3.9.04

**Complementary Electrochromic Supercapacitor for Multifunctional Smart Window** [Feichi Zhou](#); HK Polytechnic University, Hong Kong.

2:30 PM ES3.9.05

**Direct Graphenic Nanocarbon Growth on Silicon for Miniaturised Supercapacitors** [Francesca Jacopi](#); University of Technology Sydney, Australia.

2:45 PM ES3.9.06

**Fiber-Shaped Asymmetric Supercapacitors with Ultrahigh Energy Density for Flexible/Wearable Energy Storage** [Li Yong](#); University of Science and Technology Beijing, China.

3:00 PM BREAK

3:30 PM ES3.9.07

**Direct Integration of an Anodic Molybdenum Trioxide Pseudocapacitor on a Screen-Printed Silicon Solar Cell for On-Module Energy Storage** [Shi Nee Lou](#); University of New South Wales, Australia.

3:45 PM ES3.9.08

**Graphene-AgVO<sub>3</sub> Composite for Supercapacitor Applications** [Jiaqian Qin](#); Chulalongkorn University, Thailand.

4:00 PM ES3.9.09

**Synthesis of Nickel Cobalt Sulfide@Holey Graphene Hydrogel for Supercapacitors** [Sintayehu N. Tiruneh](#); Sungkyunkwan University, Korea (the Republic of).

4:15 PM ES3.9.10

**Role of Redox Additives in Inducing Three Times Higher Electrochemical Activity in Supercapacitors Based on Co<sub>3</sub>O<sub>4</sub> Nanorods** [Md. Aqueel Akhtar](#); Indian Institute of Technology Kharagpur, India.

4:30 PM ES3.9.11

**Design of Miura Folding Based Micro-Supercapacitor Arrays with Higher Areal Densities as Foldable and Miniaturized Energy Storage Units** [Bo Song](#); Georgia Institute of Technology, United States.