SYMPOSIUM CM4

In Situ Electron Microscopy of Dynamic Materials Phenomena
April 17 - April 21, 2017

Symposium Organizers
Dongsheng Li, Pacific Northwest National Laboratory
Judith Yang, University of Pittsburgh
Henry Zandbergen, Delft University of Technology
Haimei Zheng, Lawrence Berkeley National Laboratory
Yimei Zhu, Brookhaven National Laboratory

Proceedings Statement
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*TUTORIAL
Introduction to Advanced Imaging and Tomography Techniques for Transmission Electron Microscopy
Monday Morning, April 17, 2017
8:30 AM – 12:00 PM
PCC North, 100 Level, Room 127 B

This tutorial will introduce the audience to the basics, principles and applications of two advanced TEM imaging techniques:

8:30 AM - 8:40 AM
Introduction

8:40 AM - 10:10 AM
Part I: Liang Jin
High-Speed Direct Electron Detectors for In Situ TEM

In contrast to the scintillator-based Charged Coupled Device (CCD) commonly used in TEM, direct electron detectors produce images directly from high energy electrons. The high sensitivity and high speed properties of these advanced detectors have provided material scientists a tool to study dynamic processes at the milliseconds time scale while maintaining spatial resolution of sub-nanometer and better. The tutorial will cover the physics of image formation, different imaging modes including electron counting, and new image processing methods for in situ observations. Applications of the technique to in situ mechanical, liquid cell and environmental TEM will be given.

10:10 BREAK

10:30 AM - 12:00 PM
Part II: Gang Ren
Three-Dimensional Electron Tomography for Hard and Soft Materials Research

Three-dimensional (3D) structural analysis is essential to understand the relationship between the structure and function of an object. Electron tomography (ET) is a technique that retrieves 3D structural information from a tilt series of 2D projections, and is becoming a mature technology with sub-nanometer resolution. First of all, this tutorial discusses the common basis for 3D characterization, and specifies difficulties and solutions regarding both hard and soft materials research. Additionally, the tutorial will cover overview of different experimental and computational techniques used in ET. Applications will be given in 3D structural analysis of both physical-sciences research and soft materials and biomaterials research.

Instructors
Liang Jin, Direct Electron, LP
Gang Ren, Lawrence Berkeley National Laboratory

SESSION CM4.1: In Situ Characterization of Electrochemical Processing and Energy Materials
Session Chairs: Reza Shahbazian-Yassar and Chaoming Wang
Monday Afternoon, April 17, 2017
PCC North, 100 Level, Room 127 B

1:30 PM *CM4.1.01
In Situ Transmission Electron Microscopy of Advanced Materials for Li-Ion and Na-Ion Batteries Reza Shahbazian-Yassar; University of Illinois at Chicago, United States.

2:00 PM CM4.1.02
Electric-Field Induced Dynamics and In Situ Core-Shell Formation of BNT-ST Piezoelectric Nanoparticles Leopoldo Molina-Luna; TU Darmstadt, Germany.

2:15 PM CM4.1.03
Understanding the Effect of Additives in Li-Ion and Li-Sulfur Batteries by Operando ec- (S)TEM B. Layla Mehdi; Pacific Northwest National Laboratory, United States.

2:30 PM CM4.1.04
Understanding the Origins of Activity through In Situ Annealing and Dealloying of Fuel Cell Catalysts David Cullen; Oak Ridge National Laboratory, United States.

2:45 PM CM4.1.05
Base Growth vs Tip Growth Mechanism via In Situ Multimodal Study of Sodium/Lithium Metal Deposition Using Electrochemical Liquid Cell Zhiyuan Zeng; Lawrence Berkeley National Laboratory, United States.

3:00 PM BREAK

3:30 PM *CM4.1.06
In Situ TEM Probing of Structural and Chemical Evolution of Energy Materials—Rechargeable Batteries and Fuel Cells Chongmin N. Wang; Pacific Northwest National Laboratory, United States.

4:00 PM CM4.1.07
In-Liquid Observation of Electrodeposition Processes Using In Situ Transmission Electron Microscopy Levla Soleymani; McMaster University, Canada.

4:15 PM CM4.1.08
Redox Mechanism Differences in Copper Systems Studied via In Situ TEM and Atomistic Simulations Judith C. Yang1, 2; University of Pittsburgh, United States; 2University of Pittsburgh, United States.

4:30 PM CM4.1.09
Effect of Structural Order on Pulsed Laser Crystallization Kinetics of Anomorphous Germanium Thin Films Tian T. Li; Lawrence Livermore National Lab, United States.

SESSION CM4.2: Liquid and Gas Environmental TEM Methods, Advances and Applications
Session Chairs: Dongsheng Li and Haimei Zheng
Tuesday Afternoon, April 18, 2017
PCC North, 100 Level, Room 127 B

1:30 PM *CM4.2.01
Physical Chemistry of Nanocrystals with the Graphene Liquid Cell A. Paul Alivisatos; Lawrence Berkeley National Laboratory, United States.

2:00 PM CM4.2.02
Single-Particle Mapping of Non-Equilibrium Nanocrystal Transformations Using In Situ Liquid Cell TEM Imaging Xingchen Ye; University of California, Berkeley, United States.

2:15 PM CM4.2.03
Probing Dynamics of the Solid-Liquid Interface with In Situ Scanning Transmission Electron Microscopy Ryan Hufschmid; University of Washington, United States.
2:30 PM CM4.2.04
Understanding Interaction of Anode Materials in Lithium Ion Batteries through In Situ Transmission Electron Microscopy
Hyun-Wook Lee; Ulsan National Institute of Science and Technology, Korea (the Republic of).

2:45 PM CM4.2.05
Imaging Gas Bubble Evolution During Water Heating and Electrolysis with High-Speed Transmission Electron Microscopy
John Vance; University of Illinois at Urbana-Champaign, United States.

3:00 PM BREAK

3:15 PM CM4.2.06
Visualizing Solution Based Nanofabrication Processes
Utkur Mirsaidov; National University of Singapore, Singapore.

3:45 PM CM4.2.07
Exploring Metal Oxide Nanostructure Synthesis Mechanisms Using In Situ TEM
Lei Yu; University of Kentucky, United States.

4:00 PM CM4.2.08
Experimental Design for In Situ Measurements in a Liquid Electrochemical TEM Holder Cell
Stephen Maldonado; University of Michigan, United States.

4:15 PM CM4.2.09
Comment on In Situ (Scanning) Transmission Electron Microscopy Study of Liquid Samples
Nan Jiang; Arizona State University, United States.

4:30 PM CM4.2.10
Fabrication of Integrated Liquid Specimen for Transmission Electron Microscopy
Wei Huan Tsai; National Chiao Tung University, Taiwan.

4:45 PM CM4.2.11
Formation of Hollow Structures during Galvanic Replacement of Ag Nanocubes by Au Studied with Liquid Cell TEM
See Wee Chee; National University of Singapore, Singapore.

SESSION CM4.3: Poster Session
Tuesday Afternoon, April 18, 2017
8:00 PM - 10:00 PM
Sheraton, Third Level, Phoenix Ballroom

CM4.3.01
Nucleation and Growth Analysis of In Situ Electrochemical Deposition of Poly(3,4-ethylenedioxythiophene) (PEDOT)
Vivek Subramanian; University of Delaware, United States.

CM4.3.02
Transmission Electron Microscope Beam-Induced Delithiation of Lithiated Metal Silicate
Frederic Voisard; McGill University, Canada.

CM4.3.03
In Situ Observation of High Temperature CO2 Capture over Eutectic Mixture Promoted Magnesia-Based Composites
Soonha Hwang; Myongji University, Korea (the Republic of).

CM4.3.04
Solid Phase Crystallization of High Mobility Transparent Conducting Oxide
Sebastian Husein; Arizona State University, United States.

CM4.3.05
In Situ Calcination of Palladium Nanoparticles on Delta Alumina versus Ex-Situ Calcination
Siddardha Koneti; MATEIS, INSA de Lyon, France.

CM4.3.06
In Situ TEM Environmental Cell Optimized for EDS Studies
Julio A. Rodriguez Manzo; Hummingbird Scientific, United States.

CM4.3.07
A Modelling Approach to Determine Gas and Temperature Profiles during Catalytic Reactions in Environmental Transmission Electron Microscopy
Jayce Landow; Arizona State University, United States.

CM4.3.08
Addressing In Situ TEM Challenges Using Integrated Hardware and Software
Benjamin Miller; Gatan, Inc., United States.

CM4.3.09
Characterizing the Effects of Grain Size on Electron Beam Induced Artifacts during In Situ TEM Deformation of Al Films
Rohit Sarkar; Arizona State University, United States.

CM4.3.10
In Situ Observation of Au Nanoparticles Nucleation and Growth on Ultrathin MoS2 Substrate
Booa Song; University of Illinois at Chicago, United States.

CM4.3.11
In Situ Crystallization of YIG Thin Films on Non-Garnet Substrates
Thomas E. Gage; University of Minnesota, United States.

SESSION CM4.4: Gas Environmental TEM and Imaging of Beam Sensitive Materials
Wednesday Morning, April 19, 2017
PCC North, 100 Level, Room 127 B

8:30 AM CM4.4.01
In Situ Environmental TEM of Carbon Nanotube Oxidation, Molybdenum Sulphide Hydrogenation and the Influence of an Imaging Electron Beam
Robert Sinclair; Stanford University, United States.

9:00 AM CM4.4.02
The Role of Graphene in Mitigating Electron Beam-Induced Damage in Liquid Phase Electron Microscopy Investigated Using DNA-AuNP Conjugates
Hoduk Cho; University of California, Berkeley, United States.

9:15 AM CM4.4.03
The Low-Energy Electron Beam Does Not Damage Carbon Nanomaterials
Jae Hong Choi; Ulsan National Institute of Science and Technology (UNIST), Korea (the Republic of).

9:30 AM CM4.4.04
Imaging Beam-Sensitive Nanostructures by Transmission Electron Microscopy
Yu Han; KAUST, Saudi Arabia.

10:00 AM BREAK

SESSION CM4.5: Gas Environmental TEM and Catalysis
Wednesday Morning, April 19, 2017
PCC North, 100 Level, Room 127 B

10:30 AM CM4.5.01
Heat, Light and Electric Field Stimuli in the Environmental TEM
Peter A. Crozier; Arizona State University, United States.

11:00 AM CM4.5.02
Time Resolved Measurements to Reveal Atomic Scale Reaction Pathways Under Non-Equilibrium Conditions
Renu Sharma; National Institute of Standards and Technology, United States.

11:30 AM CM4.5.03
Aberration-Corrected Environmental TEM Investigation of Ag Catalyzed Oxidation of Carbon Nanotubes
Datong Yuchi; Arizona State University, United States.

11:45 AM CM4.5.04
Cathodoluminescence Characteristics of Stacking Faults in Semipolar InGaN/GaN Quantum Wells Structure
Mi-Hyang Sheen; Seoul National University, Korea (the Republic of).
SESSION CM4.6: In Situ TEM of Nucleation, Growth and Assembly in a Liquid Phase
Session Chairs: Utkur Miraevsky and Haimei Zheng
Wednesday Afternoon, April 19, 2017
PCC North, 100 Level, Room 127 B

1:30 PM *CM4.6.01
Liquid-Phase TEM Investigations of Nucleation James J. De Yoreo; Pacific Northwest National Laboratory, United States.

2:00 PM CM4.6.02
The Control of pH over Au Nanocrystal Growth—From Classical to Non-Classical Pathways Guomin Zhu
1, 2; University of Washington, United States; 2Pacific Northwest National Laboratory, United States.

2:15 PM CM4.6.03
Real Time Liquid Phase TEM Observations of Chain-Like and Rod-Like ZnO Formation via Oriented Attachment Lili Liu
1, 2; Pacific Northwest National Laboratory, United States; 2Texas Tech University, United States.

2:30 PM BREAK

3:30 PM *CM4.6.04
Colloidal Nanostructures—In Situ Electron Microscopy of Plasmon-Mediated Synthesis, Chemistry and Self-Assembly Elt Sutter; University of Nebraska–Lincoln, United States.

4:00 PM CM4.6.05
In Situ TEM Observation of New Biomineralization Pathways in Calcium Phosphate Crystals Kun He; University of Illinois at Chicago, United States.

4:15 PM CM4.6.06
Studying Polymer Self-Assembly by Combined Liquid Phase and Cryogenic Transmission Electron Microscopy Joseph P. Patterson; Eindhoven University of Technology, Netherlands.

4:30 PM CM4.6.07

4:45 PM CM4.6.08
Probing Ferroelectric/Ferroelastic Nanodomain Structures at Atomic Resolution with In Situ TEM Yu Deng; Nanjing University, China.

SESSION CM4.7: In Situ TEM of Mechanical Properties
Session Chair: Qian Yu
Thursday Morning, April 20, 2017
PCC North, 100 Level, Room 127 B

8:15 AM CM4.7.01
Quantified In Situ TEM Tensile Test Experiments on Ni Thin Films Prepared by New Optimised Techniques Vahid Samsevaahirvand; University of Antwerp, Belgium.

8:30 AM *CM4.7.02
In Situ TEM Study of the Mechanical Behavior of Submicron-Sized Si Zhiwei Shan; Xi’an Jiaotong University, China.

9:00 AM CM4.7.03
In Situ High Strain Rate Mechanical Testing in the Dynamic TEM Thomas Voisin
1, 2; Lawrence Livermore National Laboratory, United States; 2Johns Hopkins University, United States.

9:15 AM CM4.7.04
In Situ Tensile and Fatigue Tests on Mild Notched Oligocrystalline 316L Wires Heoan Mitevski
1, 2; University of Duisburg-Essen, Germany; 2BTU Cottbus-Senftenberg, Germany.

9:30 AM *CM4.7.05
In Situ TEM Deformation of Lightweight Alloys and Local Strain Measurements with Diffraction Imaging Andrew M. Minor
1, 2; University of California, Berkeley, United States; 2Lawrence Berkeley National Laboratory, United States.

10:00 AM BREAK

SESSION CM4.8: Atmospheric Pressure TEM
Session Chair: Judith Yang
Thursday Morning, April 20, 2017
PCC North, 100 Level, Room 127 B

10:30 AM *CM4.8.01
Transmission Electron Microscopy with Atomic Resolution at Atmospheric Pressure Xiaojing Pan
1, 2; University of California, Irvine, United States; 2University of California, Irvine, United States.

11:00 AM CM4.8.02
Study of Copper Nanocrystal Redox at Atmospheric Pressure by In Situ TEM Yuzi Liu; Argonne National Laboratory, United States.

11:15 AM CM4.8.03
Unveiling the Atomic Processes of the Accelerated Decomposition of Y2O3–Stabilized ZrO2 by Environmental TEM Benjamin Buzi
1, 2; Stanford University, United States; 2Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany.

11:30 AM CM4.8.04
In Situ TEM Monitoring of Growth Dynamics of Nanocrystalline Molybdenum Carbide Nanosheet Ziyuan Lin; The Hong Kong Polytechnic University, Hong Kong.

11:45 AM CM4.8.05
Structural Phase Transitions and Dynamics of Solid-Supported Interfacial Assemblies Ding-Shyue (Jerry) Yang; University of Houston, United States.

SESSION CM4.9: Advanced In Situ Methods, Multimodal Characterization and Data Processing
Session Chair: Huolin Xin
Thursday Afternoon, April 20, 2017
PCC North, 100 Level, Room 127 B

1:30 PM *CM4.9.01
Using Real Time Characterization Methods to Understand Surface Phase Transitions in Layered Oxide Cathode Materials Eric A. Stach; Brookhaven National Laboratory, United States.

2:00 PM CM4.9.02
In Situ Imaging with Electrons and X-Rays to Track the Conversion of Organic Inorganic Perovskite Solar Cells Jeffery A. Aguiar
1, 2; Idaho National Laboratory, United States; 2National Renewable Energy Laboratory, United States; 2University of Utah, United States.

2:15 PM CM4.9.03
Dynamic XPS Measurements for Observing and Monitoring Surface Reactions Christian Kaiser; Sigma Surface Science GmbH, Germany.

2:30 PM CM4.9.04
Evolution of Electronic Structure on Transition Metal and Transition Metal Doped Titanium Disulphide by High Resolution Photoemission Spectroscopy Study Xiaoyu Cui; Canadian Light Source, Canada.

2:45 PM CM4.9.05
In Situ Probing of Surface States on Nanoparticles Qianlang Liu; Arizona State University, United States.

3:00 PM BREAK

3:30 PM *CM4.9.06
5D Imaging of Multi-Element and Multi-Valence Material Evolution in In Situ Environmental TEM by On-the-Fly and Analytical Electron Tomography Huolin L. Xin; Brookhaven National Lab, United States.

4:00 PM CM4.9.07
Rapid Tomography in Environmental TEM—Solutions for a Fast Analysis of Nano-Materials in 3D under In Situ Conditions Siddardha Koneti; Univ Lyon, INSA-Lyon, France.

4:15 PM CM4.9.08
In Situ STEM-EELS Study on Cation Exchange Reactions at Nanoscale Alberto Casa; King Abdullah University of Science and Technology, Saudi Arabia.
SESSION CM4.9: Big Data Analytics for Scanning Transmission Electron Microscopy

Ptychography Alex Belianinov; Oak Ridge National Laboratory, United States.

SESSION CM4.10: In Situ EBSD Investigation of Cold Rolling Reduction Effect on Microstructure and Texture Evolution during Recrystallization of Commercial Pure Aluminum Alloy Khaled F. Adam; WSU, United States.

SESSION CM4.11: Ultra-Fast Electron Microscopy and Solid-State Materials Dynamics


SESSION CM4.12: Advanced In Situ Methods and Multimodal Characterization

High Performance Direct Electron Camera for In Situ TEM Imaging Liang Jin; Direct Electron, LP, United States.

High-Speed Observation of Transversely Propagating Exothermic Processes in Nanoscale Thin Films Garth C. Egan; Lawrence Livermore National Laboratory, United States.

High-Speed Observation of Reversible Phase Transformations Using a Direct Detection Camera Benjamin Miller; Gatan, Inc., United States.

In Situ TEM Observation of Oxygen Vacancy Driven Structural and Resistive Phase Transitions in La$_{2/3}$Sr$_{1/3}$MnO$_3$. Sebastiaan van Dijken; Aalto University, Finland.