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BIBLIOGRAPHY — JOURNAL ARTICLES

Title	Authors	Citation	Description
Giant Radiolytic Dissolution Rates of Aqueous Ceria Observed In- Situ by Liquid-Cell TEM	Muhammad Sajid Ali Asghar, Beverley J. Inkson, Günter Möbus	*Chem. Phys. Chem.*, v18, pp1247, 2017	The dissolution rates of cerium oxide nanoparticles observed in situ, using LC-TEM are over five orders of magnitude larger than conventionally measured dissolution rates, due to the radiolytic species formed by the electron beam.
Two Types of Amorphous Protein Particles Facilitate Crystal Nucleation	Tomoya Yamazaki, Yuki Kimura, Peter G. Vekilov, Erika Furukawa, Manabu Shirai, Hiroaki Matsumoto, Alexander E.S. Van Driessche and Katsu Tsukamoto	*PNAS*, v114, pp2154, 2017	In situ observation of protein crystallization mechanisms using LC-TEM. The nucleation step of crystallization processes determine the resulting crystal structure. Researchers were able to observe that mesoscopic clusters are amorphous solid particles that act as heterogenous nucleation sites.
Applying Shot Boundary Detection for Automated Crystal Growth Analysis During In Situ Transmission Electron Microscope Experiments, Advanced Structural and Chemical Imaging	W.A. Moeglein, R. Griswold, B.L. Mehdi, N.D. Browning, J. Teuton	*Adv. Struct. Chem. Imag.*, v3, pp2, 2017	The users applied shot boundry dectection to acquired video frames of in situ liquid TEM experiments in order to identify initiation of nucleation and growth during battery charge and discharge cycles.
The Use of Graphene and Its Derivatives for Liquid-Phase Transmission Electron Microscopy of Radiation-Sensitive Specimens, Nano Letters	Hoduk Cho, Matthew R. Jones, Son C. Nguyen, Matthew R. Hauwiller, Alex Zettl, and A. Paul Alivisatos	*Nano Letters* (2017) 17, 414−420	Study demonstrates that graphene, either as a LC-TEM membrane, or added as a scavenger to silicon nitride membrane based LC-TEM systems exhibits a protective effect from DNA damaging reactive oxygen species produced during radiolysis of water.
Colloidal Covalent Organic Frameworks	Brian J. Smith, Lucas R. Parent, Anna C. Overholts, Peter A. Beaucage, Ryan P. Bisbey, Anton D. Chavez, Nicky Hwang, Chiwoo Park, Austin M. Evans, Nathan C. Gianneshi and William R. Dichtel	*ACS Central Science*, 2017, 3(1) 58-65	First published results using the Poseidon liquid heating. Researchers used Poseidon liquid heating to directly observe the formation of individual covalent organic framework (COF) nanoparticles in solution.
Sample Preparation Methodologies for In Situ Liquid and Gaseous Cell Analytical Transmission Electron Microscopy of Electropolished Specimens	Xiang Li Zhong, Sibylle Shilling, Nestor J. Zaluzec, M. Grace Burke	*Microscopy & Microanalysis* (2016) 22, 6, 1350-1359	This paper presents a workflow to prepare conventional bulk metals and alloys for in situ liquid/gaseous cell S/TEM experiments. This method combines sequential electrochemical jet polishing followed by focused ion beam (FIB) techniques to create an electron transparent regions that can be mounted on the membrane for observation. Using this technique, samples of stainless steel were prepared and imaged in situ using LC-TEM.
Real-Time Observation of Protein Aggregates in Pharmaceutical Formulations Using Liquid Cell Electron Microscopy	Lynn M. DiMemmo, A. Cameron Varano, Jonathan Haulenbeek, Yanping Liang, Kaya Patel, Madeline J. Dukes, Songyan Zheng, Mario Hubert, Steven P. Piccoli and Deborah F. Kelly	*Lab Chip*, 2017,17, 315-322	Aggregation of protein derived drugs leads to reduced efficacy, shelf life and immunogenic responses in patients. In this study, the the aggregation behavior of the drug, PEGylated Interferon α2a, was studied in response to different conditions using LC-TEM. Researchers were able to observe aggregate migration, association and growth in solution of protein based therapeutics through the use of LC-TEM which can n provide insight into strategies for prevention of protein aggregation and thereby reduce potential for immunogenic responses in patients during drug therapy.
Anisotropic Shape Changes of Silica Nanoparticles Induced in Liquid with Scanning Transmission Electron MicroscopyAnisotropic Shape Changes of Silica Nanoparticles Induced in Liquid with Scanning Transmission Electron Microscopy	Jovana Zečević, Justus Hermannsdorfer, Tobias Schuh, Krijn P de Jong, Niels de Jonge	DOI: 10.1002/smll.201602466	Dissolution and anisotropic elongation of silica nanoparticles is observed during in situ liquid phase transmission electron microscopy. This study examines the chemical changes induced by electron beam ionization when imaging silca nanoparticles in liquid.
In Situ Electron Microscopy Imaging and Quantitative Structural Modulation of Nanoparticle Superlattices	Juyeong Kim, Matthew R. Jones, Zihao Ou, and Qian Chen	*ACS Nano*, 2016, 10 (11), pp 9801–9808	Gold nanoprism superlattices were used to probe localized beam induced liquid dynamics in situ, and its effect on nanoparticle movement and interactions. Movement of the lattice structures induced by PH changes from electron beam generation of hydride ions was shown to be minimal under low dose, chemically buffered conditions. Small angle X-ray scattering was used as a control.
The Impact of Li Grain Size on Coulombic Efficiency in Li Batteries	B. Layla Mehdi, Andrew Stevens, Jiangfeng Qian, Chiwoo Park, Wu Xu, Wesley A. Henderson, Ji-Guang Zhang, Karl T. Mueller & Nigel D. Browning	*Scientific Reports*, 6, 34267 (2016)	Water as an additive for lithium based electrolytes was found to result in increased lithium grain size formation on an the electrode during cyclic voltametry. The increased grain size of the lithium was found to result in higher coloumbic efficiency of the cell.
Anomalous Growth and Aggregation Dynamics of Hybrid Perovskite Nanoparticles Observed by Liquid-Cell TEM	Fuyu Qin, Zhiwei Wang, and Zhong Lin Wang	*ACS Nano*, 2016, 10 (11), pp 9787–9793	Hybrid organic-inorganic perovskite nanoparticles were nucleated in situ using LC-TEM via beam assisted solvent evaporation of dimethyl formamide. Aggregation behavior and coalescence of the nanoparticles was observed via an oriented attachment mechanism.
Fractal Growth of Platinum Electrodeposits Revealed by in situ Electron Microscopy	Lifen Wang, Jianguo Wen, Huaping Sheng and Dean J. Miller	*Nanoscale*, 2016,8, 17250-17255	Platinum electrodeposition onto the surface of glassy carbon electrodes during cyclic voltammetry experiments was characterized. Fractal growth of platinum occurred during early growth and surface roughnesss of the electrode and ion diffusion were found to be integral to the resulting deposited platinum structures.
Importance and Challenges of Electrochemical in Situ Liquid Cell Electron Microscopy for Energy Conversion Research	Nejc Hodnik, Gerhard Dehm, and Karl J. Mayrhofer	*Acc. Chem. Res*. 2016, 49 (9), pp 2015-2022	Review paper addressing current techniques and challenges for in situ electrochemicstry using LC-TEM.
Direct-Write Liquid Phase Transformations with a Scanning Transmission Electron Microscope	Raymond R. Unocic,Andrew R. Lupini, Albina Y. Borisevich, David A. Cullen, Sergei V. Kalinina, and Stephen Jesse	*Nanoscale*, 2016, 8, 15581	A direct-write nanolithographic method was developed to enable precise nanostructures to be formed by reducing palladium metal from a solution of H2PdCL4 using in situ liquid cell scanning transmission electron microscopy. Using a custom designed scanning electron nanopositioning system (SENS) the dose and trajectory of the STEM beam was precisely controlled to enable accurate deposition of metal onto the silicon nitride membrane of the in situ liquid cell.
1D Oriented Attachment of Calcite Nanocrystals: Formation of Single-Crystalline Rods Through Collision	Mihiro Takasaki, Yuki Kimura, Tomoya Yamazaki, Yuya Oaki and Hiroaki Imai	*RSC Adv*., 2016, 6, 61346-61350	As part of a larger study, liquid-cell transmission electron microscopy was used to image the process of one dimensional orientated attachment of calcite nanoblocks in situ.

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Growth of dendritic nanostructures by liquid-cell transmission electron microscopy: a reflection of the electron-irradiation history	Nabeel Ahmad, Yann Le Bouar, Christian Ricolleau and Damien Alloyeau	*Advanced Structural and Chemical Imaging*, 2016, 2:9	In situ LC-TEM study of beam induced growth of gold nanodendrites. The formation of the dendridic structure is controlled by a diffusion limited growth mechanism.
Imaging the Hydrated Microbe-Metal Interface Using Nanoscale Spectrum Imaging	Edward A. Lewis, Helen Downie, Richard F. Collins, Eric Prestat, Jonathan R Lloyd and Sarah J. Haigh	*Part. Part. Syst. Charact*., 2016, 33: 833–841	Intact bacteria cells that synthesize metallic nanoparticles from precursers in their environment were imaged in situ using LC-STEM. EDS maps of the bacteria revealed showed the elemental make-up ofAuPd core-shell nanoparticles both within and on the surface of the bacteria.
Precise In Situ Modulation of Local Liquid Chemistry via Electron Irradiation in Nanoreactors Based on Graphene Liquid Cells	Canhui Wang, Tolou Shokuhfar and Robert F. Klie	*Adv. Mater*., 2016, 28:7716-7722	Graphene liquid cells enable small volumes of liquid to be encapsulated for in situ liquid imaging. This paper examines the effect of electron dose on the concentration of radiolysis products and provides some comparison to silicon nitride based dedicated in situ liquid TEM holders (Poseidon).
Observing Growth of Nanostructured ZnO in Liquid	Ting-Huan Hsieh, Jui-Yuan Chen, Chun-Wei Huang, and Wen-Wei Wu	*Chem. Mater.,* v28, pp4507, 2016	Heat generated by the electron beam LC-TEM imaging at 200 KV was used to initaite the hydrothermal synthesis of zinc oxide nanowires. A two step nanowire growth process was observed and characterized.
In Situ Observation of Hematite Nanoparticle Aggregates Using Liquid Cell Transmission Electron Microscopy	Juan Liu, Zhiwei Wang, Anxu Sheng, Feng Liu, Fuyu Qin, and Zhong Lin Wang	*Environ. Sci. Technol*. 2016, 50, 5606−5613	The aggregation dynamics and behavior or hematite nanoparticles was studied using liquid cell transmission electron microscopy. The impact of nanoparticle size and ionic strength of the liquid as a function of aggregation was quantified. Salt solutions, such as NaCl were found to drive aggregation as the ionic strength was increased. and resulted in more stable aggregates over time.
Synergistic Biomineralization Phenomena Created by a Combinatorial Nacre Protein Model System	Eric P. Chang, Teresa Roncal-Herrero, Tamara Morgan, Katherine E. Dunn, Ashit Rao, Jennie A. M. R. Kunitake, Susan Lui, Matthew Bilton, Lara A. Estroff, Roland Kröger, Steven Johnson, Helmut Cölfen, and John Spencer Evans	*Biochemistry*, 2016, 55 (16), pp 2401–2410	The synergistic cooperation between two different nacre proteins was studied to determine how different ratios of proteins work together to form calcite crystals. Liquid cell scanning transmission electron microscopy was used to image the in situ mixing and protein mediated growth of calcite nanostructures.
In-Situ Liquid TEM Study on the Degradation Mechanism of Fuel Cell Catalysts	Hisao Kato	*SAE Int. J. Alt. Power*. 5(1):189-194	Development and and characterization of custom MEMS electrochemistry E-chips for use with Protochips' Poseidon holder for in situ liquid cell TEM experiements.
Impact of Membrane-Induced Particle Immobilization on Seeded Growth Monitored by In Situ Liquid Scanning Transmission Electron Microscopy	Rebecca G. Weiner, Dennis P. Chen, Raymond R. Unocic and Sara E. Skrabalak	*Small*, 2016, 12, No. 20, 2701–2706	LC-STEM was used to deposit palladium metal via electron beam deposition onto gold nanocube seed particles to form bimetallic nanoparticles.
Live Bacterial Physiology Visualized with 5 nm Resolution Using Scanning Transmission Electron Microscopy	Eamonn Kennedy, Edward M. Nelson, Tetsuya Tanaka, John Damiano, Gregory Timp	*ACS Nano,* v10, pp2669, 2016	First reported results of live cell processes imaged with LC-STEM. Contrast was enhanced using heavy metal staining and processes such as cellular fission and bacterial phage infection of E.coli were observed in situ.
Atomistic Insights into the Oriented Attachment of Tunnel-Based Oxide Nanostructures	Yifei Yuan, Stephen M. Wood, Kun He, Wentoa Yao, David Tompsett, Jun Lu, Anmin Nie, M. Saiful Islam, Reza Shabazian-Yassar	*ACS Nano,* v10, pp539, 2016	In situ LC-STEM was utilized in conjunction with conventional microscopy techniques to probe the growth mechanism of alpha-MnO2 nanowires, which were found to grow via oriented attachment.
Real-time imaging of lead nanoparticles in solution – determination of the growth mechanism	Diana L. Delach, Madeline J. Dukes, A. Cameron Varono, Deborah F. Kelly, Albert D. Dukes III	*RSC Advances,* v5, pp104193, 2015	Electron-beam induced growth of lead nanoparticles from a solution of lead nitrate using a 120 KV acceleration voltage. A two-phase growth mechanism was observed after the initial particle nucleation: oswaldt ripening followed by aggregative growth resulting in the formation of micron-scale particles.
Quantitative Description of Crystal Nucleation and Growth from in Situ Liquid Scanning Transmission Electron Microscopy	Anton V. Ievlev, Stephen Jesse, Thomas J. Chochell, Raymond R. Unocic, Vladimir A. Protopopescu, Sergei V. Kalinin	*ACS Nano,* v9, pp11784, 2015	The nucleation and growth of platinum nanoparticles from a precurser solution of K2PtCl6 was observed using LC-STEM. Comprehensive data analysis of the growth mechanism shows that the nanoparticle growth is controlled by a stationary diffusional transport mechanism.
Electron beam induced chemistry of gold nanoparticles in saline solution	J. Hermannsdorfer, N. de. Jonge and A. Verch	*Chem. Commun.,* v51, pp16393, 2015	This study examines the effects of parameters such as chloride concentration (ionic strength), pH and electron dose on the stability of gold nanopaticle in situ using LC-TEM.
Visualizing virus particle mobility in liquid at the nanoscale	A. Cameron Varano, Amina Rahimi, Madeline J. Dukes, Steven Poelzing, Sarah M.	*Chem. Commun.,* v51, pp16176, 2015	In situ visualization of RNA movement inside an actively transcribing rotavirus imaged using LC-TEM. The magnitude of dynamic movement within the electron dense core of the rotavirus increases with increasing transcriptional activity of the virus.
Carbon Nanotube Degradation in Macrophages: Live Nanoscale Monitoring and Understanding of Biological Pathway	Dan Elgrabli, Walid Dachroaui, Cecilia Menard-Moyon, Xiao Jie Liu, Dominque Begin, Sylvie Begin-Colin, Alberto Bianco, Florence Gazeau, Damien Alloyeau	*ACS Nano,* v9, pp10113, 2015	Radiolysis of water by the electron beam was exploited to generate reactive oxygen species to mimic the chemical environment of a macrophage cell using LC-TEM in order to study the degradation of carbon nanotubes in situ.

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Direct Imaging of the Electrochemical Deposition of Poly(3,4-ethylenedioxythiophene) by Transmission Electron Microscopy	Jinglin Liu, Bin Wei, Jennifer D. Sloppy, Liangqi Ouyang, Chaoying Ni, and David C. Martin	*ACS Macro Lett.,* v4, pp897, 2015	Conjugated polymers are electronically and ionically active organic materials of interest for use in a variety of devices. This paper demonstrates the electrochemical deposition of a PEDOT (poly(3,4-ethylenedioxythiophene)) film onto a glassy carbon working electrode using the Poseidon in situ LC-(S)TEM system.
Visualization of film-forming polymer particles	Lili Liu, Yi Liu, Enjun Wu, Christopher M. Miller and Elizabeth C. Dickey	*Analyst,* v140, pp6330, 2015	Latex polymer particles, such as those found in ink and paint binders, were imaged in situ using LC-TEM. The formation of thin films was observed to occur as the latex particles coalesced during the transition from a liquid to a dry state.
Phosphorus-Doped p−n Homojunction ZnO Nanowires: Growth	Wei-Che Lee, Jui-Yuan Chen, Chun-Wei Huang, Chung-Hua Chiu, Ting-Yi Lin, Wen-Wei Wu	*Chem. Mater.,* v27, pp4216, 2015	Growth dynamics of ZnO nanowires imaged in situ using LC-TEM. A threefold growth mechanism consisting of solute fluctuation, crystal precipitation, and crystal growth was observed.
Exceptionally Slow Movement of Gold Nanoparticles at a Solid/Liquid Interface Investigated by Scanning Transmission Electron Microscopy	Andreas Verch, Marina Pfaff, and Niels de Jonge	*Langmuir,* v31, pp6956, 2015	Gold nanoparticles imaged in situ using LC-STEM move at a rate which is three orders of magnitude slower than predicted by brownian motion. This study examines the effect of parameters such as nanoparticle charge, membrane charge, viscosity and ionic strength on the rate of movement of gold nanoparticles in situ.
Interaction Potentials of Anisotropic Nanocrystals from the Trajectory Sampling of Particle Motion UsingIn Situ Liquid Phase Transmission Electron Microscopy	Chen, Qian, Hoduk Cho, Karthish Manthiram, Mark Yoshida, Xingchen Ye and A. Paul Alivisatos	*ACS Central Science,* v1, pp33, 2015	The movement of gold nanorods in solution were observed and recorded in situ using LC-STEM. The relative trajectories of these nanoparticles were analyzed to analyze and measure the interaction potential between nanoparticles to study in situ self assembly mechanisms.
Unravelling Kinetic and Thermodynamic Effects on the Growth of Gold Nanoplates by Liquid Transmission Electron Microscopy	Alloyeau, Damine, Walid Dachraoui, Yasir Javed, Hannen Belkahla, Guillaume Wang, Hélène Lecoq, Christian Ricolleau, et al.	*Nano Letters,* v15, pp2574, 2015	Mechanistic and kinetic study that examines the effect of electron dose on the growth and faceting of 2D and 3D gold nanoparticles in situ using LC-STEM.
Real-time Visualization of Nanoparticles Interacting with Glioblastoma Stem Cells	Pohlmann, Elliot S., Kaya Patel, Sujuan Guo, Madeline J. Dukes, Zhi Sheng and Deborah F. Kelly	*Nano Letters,* v15, pp2329, 2015	This study demonstrates the capability of LC-TEM to visualize interactions between nanoparticle-based therapies, such as gold nanorods, and glioblastoma stem cells in situ.
Observation and Quantification of Nanoscale Processes in Lithium Batteries by Operando Electrochemical (S) TEM	B. Layla Mehdi, Jun Qian, Eduard Nasybulin, Chiwoo Park, David A. Welch, Rolland Faller, Nigel D. Browning, et al.	*Nano Letters,* v15, pp2168, 2015	In situ LC-STEM imaging and operando electrochemical analysis of a lithium battery system during its charge/discharge cycle. Dendrite formation and build-up is observed on the platinum working electrode as the system is electrochemically cycled demonstrating the process of capacity fading and lithium loss from an electrochemical cell.
Nanoscale Imaging of Fundamental Li Battery Chemistry: Solid-Electrolyte Interphase Formation and Preferential Growth of Lithium Metal Nanoclusters	Sacci, Robert L., Jennifer M. Black, Nina Balke, Nancy J. Dudney, Karren L. More and Raymond R. Unocic	*Nano Letters,* v15, pp2011, 2015	The formation of the solid electrolyte interphase (SEI) layer on the surface of working electrode and site-specific formation of lithium nanostructures were observed during electrochemical potential sweeps of lithium hexafluorophosphate battery material i using LC-STEM.
An Oligomeric C-RING Nacre Protein Influences Pre-Nucleation Events and Organizes Mineral Nanoparticles	Perovic, Iva, Andreas Verch, Eric P. Chang, Ashit Rao, Helmut Cölfen, Roland Kröger, and John Spencer Evans	*Biochemistry,* v53, pp7259, 2014	Biomineralization study of the role of the shellfish nacre protein, AP7 on the formation of protein stabilized calcite nanstructions using LC-STEM. The precurser solutions were simultaneously mixed in situ and the nucleation and growth were observed in situ in real-time.
In Situ Liquid Cell TEM Study of Morphological Evolution and Degradation of Pt-Fe Nanocatalysts During Potential Cycling	Guo-Zhen, Zhu, Sagar Prabhudev, Jie Yang, Christine M. Gabardo, Gianluigi A. Botton, and Leyla Soleymani	*J. Phys. Chem. C,* v118, pp22111, 2014	The degradation of Pt-FE nanocatalysts after repeated charge/discharge cycles was studied in situ using LC-TEM. Cycling of the electrochemical potential caused nanocatalyst particles' ato undergo a coarsening processes, which occured at different rates depending on the particles' location on the electrode or within the electroyte.
Writing Silica Structures in Liquid with Scanning Transmission Electron Microscopy	van de Put, Marcel W.P., Camille C.M.C. Carcouet, Paul H.H. Bomans, Heiner Friedrich, Niels de Jonge and Nico A.J.M. Sommerdjik	*Small,* v11, pp585, 2014	Electron beam induced formation of silica crystals on the surface of a SiN membrane after silica nanoparticles are exposed to electron beam irradiation. The researchers used this technique to control production of sub-micrometer scale structures in liquid.
X-ray Energy-Dispersive Spectrometry During In Situ Liquid Cell Studies Using an Analytical Electron Microscope	Zaluzec, Nestor J., M. Grace Burke, Sarah J. Haigh and Matthew A. Kulzick	*Microsc. Microanal.,* v20, pp323, 2014	This paper describes results using a modified Poseidon 200 in situ TEM holder to optimize X-ray energy dispersive spectroscopy (EDS) of specimens in liquid by improving the line of sight from the specimen to the EDS detector.
Real-Time Imaging and Local Elemental Analysis of Nanostructures in Liquids	Lewis, Edward, Sarah Haigh, Thomas Slater, Zheyang He, Matthew Kulzick, Mary Grace Burke, and Nestor J. Zaluzec	*Chem. Commun.,* v50, pp10019, 2014	First results demonstrating in situ elemental mapping of nanoparticles in liquid using EDS.

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Estimating the effective density of engineered nanomaterials for in vitro dosimetry	Glen DeLoid, Joel M. Cohen, Tom Darrah, Raymond Derk, Liying Rojanasakul, Georgios Pyrgiotakis, Wendel Wohlleben, Philip Demokritou	*Nat. Commun.,* v5, article number 3514, 2014	In situ LC-TEM images of agglomerates of CeO2 particles are presented as part of a larger study on the development of a method to quantify dosimetry data from samples prepared using centrifugation prepared.
Liquid Scanning transmission Electron Microscopy: Imaging Protein Complexes in their Native Environment in Whole Eukaryotic Cells	Peckys, Diana B., and Niels de Jonge	*Microsc. and Microanal.,* v20, pp346, 2014	Literature review of the development of liquid scanning transmission electron microscopy as a technique to image whole eukaryotic cells.
Nanoscale Imaging of Lithium Ion Distribution during In Situ Operation of Battery Electrode and Electrolyte	Holtz, Megan E., Yingchao Yu, Deniz Gunceler, Jie Goa, Ravishankar Sundararaman, Kathleen A. Schwarz, David A. Muller, et al.	*Nano Letters,* v14, pp1453, 2014	The battery material, LiFePO4, was electrochemically charged and discharged in situ using LC-STEM. The lithiation state of the material during electrochemical cycling was identified and tracked in real time using valence electron-energy loss spectroscopy (EELS).
Liquid Scanning Transmission Electron Microscopy: Nanoscale Imaging in Micrometers-Thick Liquids	Schuh, Tobias, and Niels de Jonge	*Competes Rendus Physique,* v15, pp214, 2014	Time-lapse imaging of gold nanoparticles in solution and nanoparticle tagged proteins in whole eukaryotic cells imaged with LC-STEM.
Quantitative Electrochemical Measurements Using In Situ ec-S/TEM Devices	Unocic, Raymond R., Robert L. Sacci, Gilbert M. Brown, Gabriel M. Veith, Nancy J. Dudney, John Damiano, David Nackashi, et al.	*Microsc. and Microanal.,* v20, pp452, 2014	Study demonstrating the electrochemical capabilities of the Poseidon in situ LC-(S) TEM system. Cyclic voltammetry, chronoamperometry, and electrochemical impedance measurements were conducted using ferrocyanide electrolyte.
In Situ TEM of Biological Assemblies in Liquid	Dukes, Madeline J., Brian L. Gilmore, Justin R. Tanner, Sarah M. McDonald and Deborah F. Kelly	*J. Vis. Exp.,* v82, e50936, 2013	Method paper and corresponding video demonstrating step-by-step instructions for preparing “affinity-capture” functionalized Poseidon E-chips, capturing target species and imaging them in situ in liquid with TEM.
Improved Microchip Design and Application for In Situ Transmission Electron Microscopy of Macromolecules	Dukes, Madeline J., Rebecca Thomas, John Damiano, Kate L. Klein, Sharavanan Balasubramaniam, Sanem Kayandan, Deborah F. Kelly, et al.	*Microsc. and Microanal.,* v20, pp338, 2013	The development and use of integrated microwells for in situ LC-(S)TEM imaging. Samples imaged in microwells include magnetic resonance imaging contrast reagents, transcribing viral assembles (rotavirus) and liposome carrier vehicles.
In-Situ Transmission Electron Microscopy of Liposomes in an Aqueous Environment	Sarah M. Hoppe, Darryl Y. Sasaki, Aubrianna N. Kinghorn, Khalid Hattar	*Langmuir,* v23, pp 9958, 2013	Liposomes composed of 1-palmitoyl-2-oleoyl-sn- glycero-3- phosphocholine (POPC) were imaged using LC-TEM. Liposome movement and interaction were observed as they were flowed through the holder tip and the effect of surface treatment and lipid additives on the liposome structure was also studied.
Dendritic Gold Nanowire Growth Observed in Liquid with Transmission Electron Microscopy	Kraus, Tobias, and Niels de Jonge	*Langmuir,* v29, pp8427, 2013	Images and movies showing the beam induced growth process of gold nanodendrites nanoparticle seed precursors. Dendrite growth rates were quantified and found that both the geometry of dendritic tip growth and grain structure correlated with growth speed.
In Situ Electron Energy-Loss Spectroscopy in Liquids	Holtz, Megan E., Yingchao Yu, Hector D. Abruna and David Muller	*Microsc. and Microanal.,* v19, pp1027, 2013	Paper demonstrates how in situ EELS can benefit materials analysis in both spectroscopy and imaging (EFTEM) modes for liquid electron microscopy. The capabilities of EELS in liquid are examined, and core and low-loss areas of the EELS spectrum are evaluated as a function of liquid thickness. EFTEM imaging in the low and zero-loss region is also discussed.
Visualizing Nanoparticle Mobility in Liquid at Atomic Resolution	Dukes, Madeline J., Benjamin W. Jacobs, David G. Morgan, Harshad Hegde and Deborah F. Kelly	*Chem. Commun.,* v49, pp3007, 2013	Live video imaging of the mobility of polyvinyl pyridine (PVP)- passivated gold nanorods and how they migrate in liquid. Nanorod movement and aggregation was imaged using an acceleration voltage of 120 KV TEM and high resolution images were obtained in situ using 300 KV TEM.
Visualizing Viral Assemblies in a Nanoscale Biosphere	Gilmore, Brian L., Shannon P. Showalter, Madeline J. Dukes, Justin R. Tanner, Andrew C. Demmert, Sarah M. McDonald and Deborah F. Kelly.	*Lab on a Chip,* v13, pp216, 2013	First example of 3D reconstruction of a biological particle from liquid in situ TEM images. A 25 Å reconstruction was obtained from 600 double layer rotavirus particles imaged in a 150 nm liquid layer. Multiple subpopulations were identified, several of which, are not observed in cryo-prepared samples indicating the dynamic state of samples in liquid versus those embedded in ice.
UV-Induced Photochemical Transformations of Citrate-Capped Silver Nanoparticle Suspensions	Gorham, Justin M., Robert I. MacCuspie, Kate L. Klein, D. Howard Fairbrother and R. David Holbrook	*J. Nanopart. Res.,* v14, pp1, 2012	LC-TEM was used to image the structure of silver nanoparticles in water after exposure to ultraviolet light (UV). Exposure to UV-light in an aqueous environment resulted in a decrease in the size of the particles and the formation of a core–shell structure. This experiment shows the utilization of in situ LC-TEM techniques for studying the environmental impact of nanomaterials.
Video Frequency Scanning Transmission Electron Microscopy of Moving Gold Nanoparticles in Liquid	Ring, E.A., and Niels de Jonge	*Micron,* v43, pp1078, 2012	In situ LC-STEM analysis of the movement of gold nanoparticles in liquid. Much slower movement was observed than what was expected on the basis of Brownian motion.

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The Development of Affinity Capture Devices: A Nanoscale Purification Platform for BiologicalIn Situ Transmission Electron Microscopy	Degen, Katherine, Madeline Dukes, Justin R. Tanner and Deborah F. Kelly	*RSC Advances,* v2, pp2408, 2012	First example of using “affinity-capture” surface modification of E-chips for tethering biological species to the E-chip surface for in situ liquid TEM imaging. Ribosome proteins expressing His-tags were captured in situ onto Ni-NTA functional E-chips and imaged in 150 nm liquid using TEM.
Fully Hydrated Yeast Cells Imaged with Electron Microscopy	de Jonge, Niels, Diana B. Peckys, G.M. Veith, S. Mick, S. Pennycook and D. Joy	*Biophys. J,* v100, pp2522, 2012	Correlative fluorescence microscopy and scanning transmission electron microscopy of whole yeast cells in liquid. Multiple strains of S. Pombe yeast cells, that express different structural mutations, were imaged live in 3 µm of liquid using STEM.
Silicon Nitride Windows For Electron Microscopy of Whole Cells	Ring, E.A., D.B. Peckys, M.J. Dukes, J.P. Baudoin and N. de Jonge	*J. Microsc.*, v243, pp 273, 2011	Review of basic techniques for preparing whole cells for in situ liquid imaging. Particular attention is given to the process of preparing the E-chips for tissue culture and culturing whole cells on the E-chips. Additional dry (non-liquid) applications which can be prepared in parallel to the in situsamples are also discussed.
Visualizing Gold Nanoparticle Uptake in Live Cells with Liquid Scanning Transmission Electron Microscopy	Peckys, Diana B., G.M. Veith, D.C. Joy and Niels de Jonge	*Nano Letters*, v11, pp1733, 2011	The uptake of 30 nm diameter gold nanoparticles into intracellular vesicles was imaged in situ with STEM using Poseidon. The images were quantitatively analyzed to determine the particle number, loading percentage, and clustering behavior after 24 hours.
Transmission Electron Microscopy with a Liquid Flow Cell	Klein, K.L., I.M. Anderson and N. de Jonge	*J. Microsc.*, v242, pp117, 2011	Characterization of spatial resolution and imaging parameters for LC-TEM/STEM using a Poseidon flow cell.
Simulating STEM Imaging of Nanoparticles in Micrometers-Thick Substrates	Demers, H., N. Poirier-Demers, Dominic Drouin and N. de Jonge	*Microsc. and Microanal.*, v16, pp795, 2011	Comparison of Monte Carlo simulations of parameters such as resolution, signal-to-noise ratio, beam broadening effect and electron scattering behavior in liquid and experimentally obtained in situ results.
Correlative Fluorescence Miccroscopy and Scanning Transmission Electron Microscopy of Quantum-Dot_ labeled Proteins in Whole Cells in Liquid	Madeline J. Dukes, Diana B. Peckys, and Niels de Jonge	*ACS Nano*, v4, pp4110, 2010	Correlative fluorescence microscopy and scanning transmission electron microscopy of COS7 cells labeled with CdSe quantum dots
Microfluidic System for Transmission Electron Microscopy	Ring, Elisabeth A., and Niels de Jonge	*Microsc. and Microanal.*, v16, pp622, 2010	Investigation of in the liquid flow parameters through a liquid chamber formed using Poseidon E-chips.. The flow was investigated optically using quantum dots with wide-field fluorescence microscopy and gold nanoparticles were utilized for in-situ liquid TEM measurements.
Nanometer-Resolution Electron Microscopy Through Micrometers-Thick Water Layers	Niels de Jonge, Nicolas Poirier-Demers, Hendrix Demers, Diana B. Peckys and Dominique Drouin	*Ultramicroscopy* 110 (2010) 1114-1119	Experimental and theoretical study of the obtainable resolution for liquid cell TEM.
Atmospheric Pressure Scanning Transmission Electron Microscopy	de Jonge, Niels, Wilbur C. Bigelow and Gabriel M. Veith	*Nano Letters*, v10, pp1028, 2010	STEM imaging of gold nanoparticles at atmospheric pressure in a mixture of CO, O2, and He using the Poseidon LC-(S)TEM sample holder.
Nanoscale Imaging of Whole Cells Using a Liquid Enclosure and a Scanning Transmission Electron Microscope	Peckys, Diana B., Gabriel M. Veith, David C. Joy and Niels de Jonge	*PLoS ONE*, v4, e8214., 2010	Overview of whole cell sample preparation and techniques for in situ LC-STEM applications.
Electron Microscopy of Whole Cells in Liquid With Nanometer Resolution	de Jonge, N., D.B. Peckys, G.J. Kremers and D.W. Piston	*Proc. Natl. Acad. Sci.*, v106, pp2159, 2010	First example of whole cells imaged in liquid using in situ LC-STEM. Chemically fixed COS cells were labeled with EGF-targeted gold nanoparticles and imaged using HAADF STEM. The paper also includes a discussion on the theoretical parameters of resolution and in situ beam broadening.