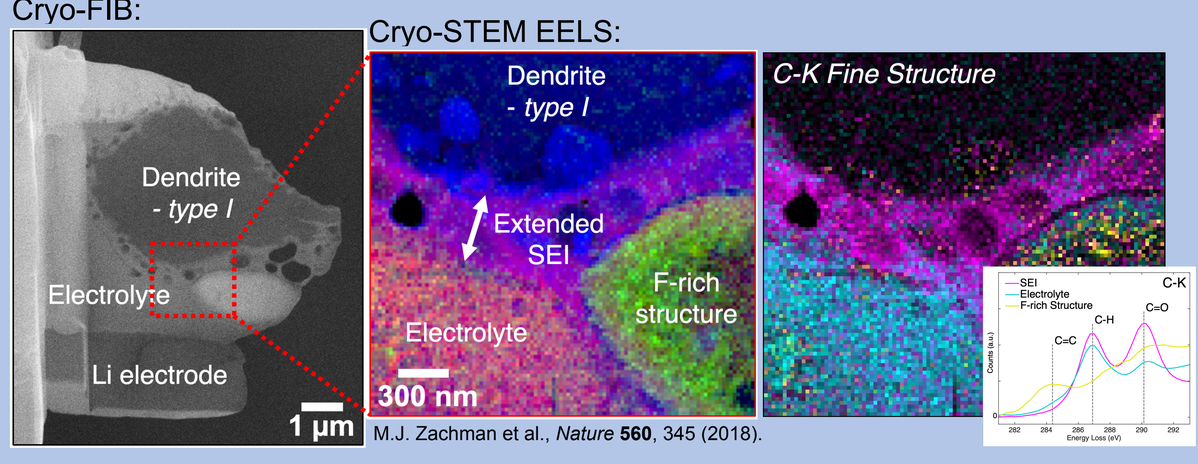
Lena Fitting Kourkoutis
1979-2023

Lena Fitting was born in June, 1979 in Rostock, Germany (former East Germany). She did her Diplom in Physics in 2003 at Rostock University, where her father was Professor of Physics; her mother was a thermal engineer. Following a Fullbright award to conduct her masters research at NC State University, she moved to Ithaca, NY in 2003 to carry out her doctoral research with Prof. David A. Muller at Cornell University, contributing to the early development of atomic-resolution spectroscopic imaging of crystalline materials and interfaces. As a postdoc at the Max Planck Institute for Biochemistry in Martinsreid, she helped advance techniques for cryogenic sample preparation and imaging, which she later adapted for pioneering advances in quantum and energy materials research after returning to Cornell in 2013 as faculty in the School of Applied and Engineering Physics (AEP). In addition to her many and far-reaching scientific contributions, Lena held several leadership roles during her tenure at Cornell, including her service as the Co-Director of PARADIM (the Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials, an NSF Materials Innovation Platform), Assistant Director of CCMR (Cornell Center for Materials Research), Co-Thrust Leader of CABES (Center for Alkaline-Based Energy Solutions), chair of the College Curriculum Governing Board, faculty advisor for Women in Physics and Related Fields, and AEP Director of Undergraduate Studies.

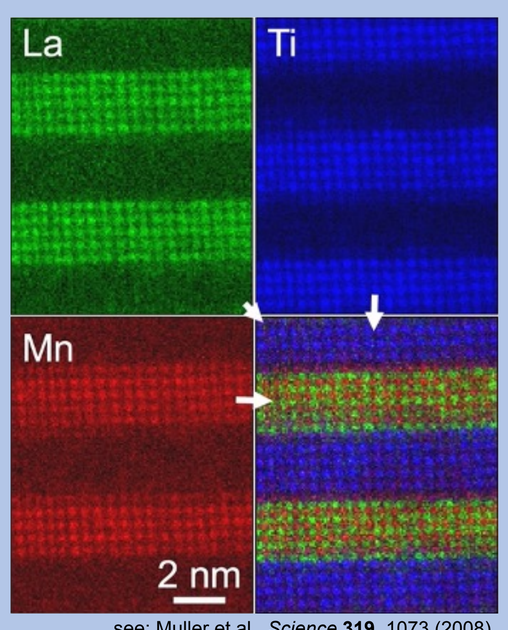
Lena was known throughout the microscopy, campus, and scientific communities for her technical excellence, commitment to mentorship, and passionate engagement. Lena passed away at age 44 on June 24, 2023 after living with colon cancer for almost two years. She is greatly missed by her husband, Chris, and their two children; her parents, twin sister Sylvia Fitting, and brother Martin Fitting; and all those who had the chance to work with and learn from her.

Cryogenic FIB and STEM to access native properties of liquid-solid interfaces



M.J. Zachman et al., *Nature* **560**, 345 (2018).

Lena pioneered development of cryogenic focused ion beam (cryo-FIB) and analytical cryogenic scanning transmission electron microscopy (cryo-STEM) techniques that allow structures and interfaces buried within large samples and devices to be preserved in nearly native states, extracted, and characterized at high resolution. These techniques provide a pathway to study a range of materials systems that were previously challenging or impossible to probe by conventional techniques, such as those including air-sensitive materials and/or liquids. The significance of these technical advancements and the insights they provided were recognized by *Nature*, which published the first report of cryo-FIB and cryo-STEM applied to a lithium battery system. By preserving the native structure and composition of the interface between the liquid electrolyte and reactive lithium metal electrode/dendrite structures, an extended solid-electrolyte interphase (SEI) layer and a class of dendrite composed primarily of lithium hydride were observed for the first time. The success and impact of these techniques continues to grow, with many laboratories across academia, national laboratories, and industry now employing cryo-FIB and cryo-STEM to provide novel information about previously inaccessible materials systems.

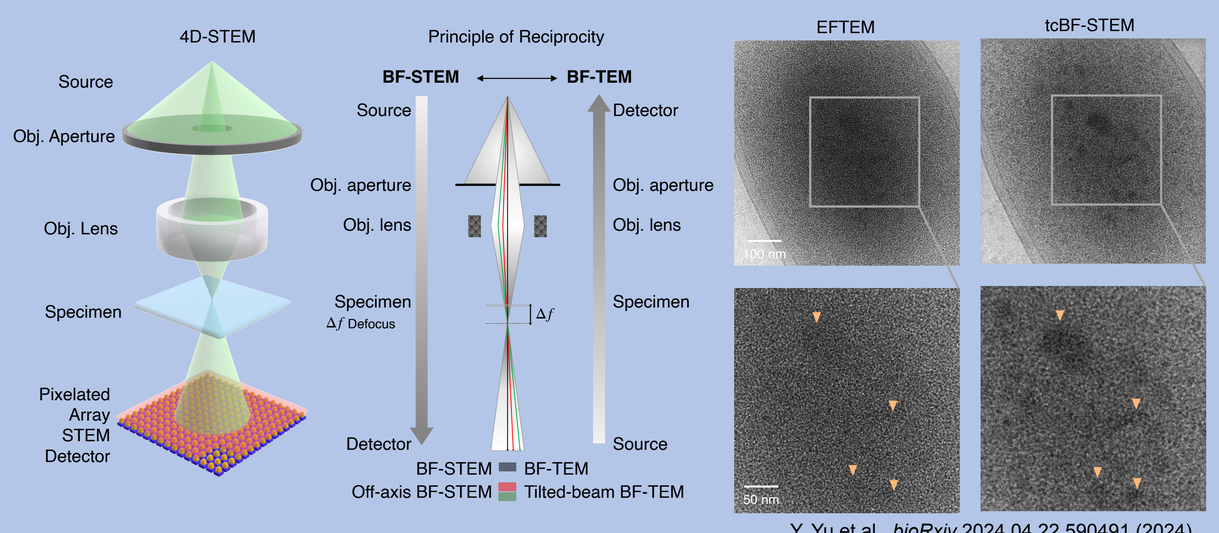


see: Muller et al., *Science* **319**, 1073 (2008).

Graduate work at Cornell

Lena's PhD thesis "Atomic-Scale Studies of Structure and Bonding at Perovskite Oxide Heterointerfaces" focused on the development of atomic-resolution STEM and electron energy loss spectroscopy (EELS) to study structure and bonding in complex oxides and heterostructures. Incorporation of the recently introduced aberration-correction into her PhD work allowed her to perform atomic-resolution spectroscopic mapping, which she applied to show how complex oxides accommodated cation defects and how previously-assumed intrinsically "dead" electronic layers at interfaces were instead the result of cation intermixing driven by off-stoichiometric growth and could in fact be suppressed. In addition to her hard work in the lab, she found time for outside activities including music and volunteering, becoming an active member of the greater Ithaca community.

Tilt-corrected bright-field STEM for thick biological specimens

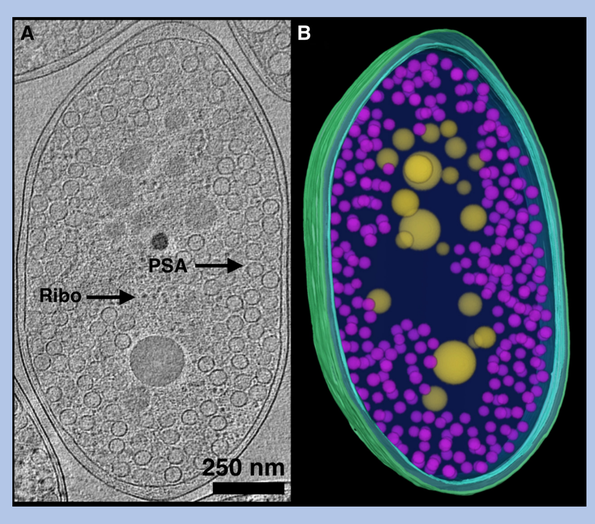


Y. Yu et al., *bioRxiv* 2024.04.22.590491 (2024).

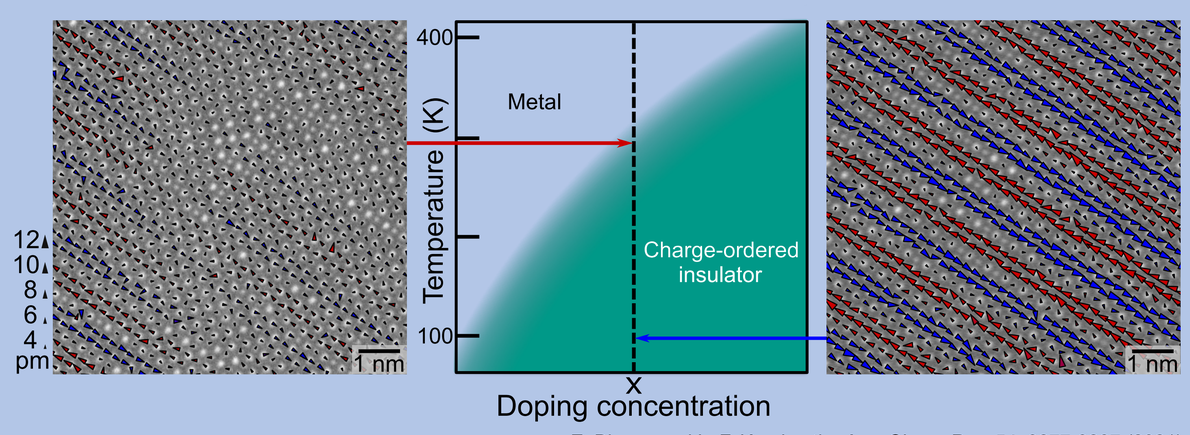
Lena combined her expertise in high-resolution imaging and biological cryoEM to study frozen-hydrated specimens with STEM. She conducted the first 4D-STEM experiments utilizing the newly developed EMPAD detector on frozen-hydrated cells and macromolecules. Together with David Muller, she developed a technique called tilt-corrected bright-field (tcBF) STEM, in which coherent images are formed from each detector pixel in the bright field disk and combined by cross correlation to correct for the tilt-induced image shifts. The technique shows promise for imaging thick specimens where a larger proportion of electrons are inelastically scattered and lead to chromatic blurring, and are therefore typically discarded using an energy filter in conventional TEM experiments. In STEM, however, the focusing optics are prior to the specimen and inelastic scattering is much less of a detriment. This is especially important for dose-sensitive biological specimens where resolution is ultimately limited by the tolerable dose. Lena's contributions to STEM for biological imaging helped drive a larger trend of increasing interest in related techniques, especially electron ptychography for single particle analysis.

"Life in Cryo" postdoc at MPIB, Martinsreid

As a Humbolt Research Fellow from 2010-2011, Lena trained in cryo-electron microscopy techniques in Wolfgang Baumeister's Molecular Structural Biology Group at the Max Planck Institute of Biochemistry in Martinsried, Germany. There, she developed new cryogenic scanning transmission electron microscopy techniques which she would later adapt in her group at Cornell to gain access to low-temperature electronic states, study processes at liquid/solid interfaces, and image thick biological specimens. Despite many experimental and technical challenges, Lena demonstrated the positivity and grit she was known for during the installation and development of new tools, including a prototype Titan Krios, and procedures, such as cryo-FIB milling. Even after her return to Cornell and her contributions to energy and quantum materials fields, Lena remained an active in the cryo-for-bio and cryo-FIB communities.



Cryogenic STEM for accessing new phases in quantum materials



E. Bianco and L. F. Kourkoutis, *Acc. Chem. Res.* **54**, 3277-3287 (2021).

Drawing on her expertise in liquid nitrogen-cooled experiments for biology, Lena developed new strategies to enable quantitative, sub-Ångström-resolution imaging and spectroscopy of quantum materials at liquid nitrogen temperatures, where exotic phases not present at ambient temperatures can emerge. This capability opened unprecedented access to probe — with near-picometer precision — ordered atomic displacements in strongly correlated charge density waves. In collaboration with Henny Zandbergen, she extended the accessible temperatures of cryo-STEM to span the full range from ~100 to nearly 1000 K, introducing the capability to track phase transitions driven by temperature or electrical bias within a single, fixed field of view at atomic resolution. These experimental advances are pushing STEM to the forefront of condensed matter physics research, particularly with growing efforts to reach liquid helium temperatures.

Outreach, Education, and Professional Service

A passionate educator, Lena especially loved teaching first-semester undergraduates in Cornell's College of Engineering course on nanocharacterization. Since her time as a graduate student, she was also active in scientific outreach, particularly at the elementary-, middle-, and high-school levels. As a graduate student, she organized the annual Expanding Your Horizons (EYH) Conference at Cornell for middle-school girls to experience STEM through hands-on activities on campus. As faculty, her group helped develop classroom teaching kits through CCMR, including How Microscopes Work to give students a closer look at principles of lenses and magnification.

Lena was an active member of the wider microscopy and research communities, serving on several research advisory boards and organizing microscopy and materials research conferences, including co-organizing national meetings of the Materials Research Society and Microscopy Society of America.

Honors and Awards

- Cornell Engineering Research Excellence Award, 2021
- Microscopy and Microanalysis Best Paper Award, Microscopy Society of America, 2020
- Kurt Heinrich Award, Microanalysis Society, 2020
- Cosslett Award, Microanalysis Society, 2020
- Burton Medal, Microscopy Society of America, 2018
- Microscopy and Microanalysis Best Paper Award, Microscopy Society of America, 2018
- Dorothy and Fred Chau Excellence in Teaching Award, College of Engineering, Cornell, 2017
- National Science Foundation Faculty Early Career Development Award (CAREER), 2017-2022
- Microscopy and Microanalysis Best Paper Award, Microscopy Society of America, 2016
- National Academy of Sciences Kavli Frontiers Fellow, 2016
- Presidential Early Career Awards for Scientists and Engineers (PECASE), 2016-2021
- Packard Fellowship for Science and Engineering, 2014-2019
- Albert Crewe Award, Microscopy Society of America, 2013
- Rebecca Q. and James C. Morgan Sesquicentennial Faculty Fellow, Cornell, 2012-2017
- Marine Biological Laboratory Scholarship, Marine Biological Laboratory, 2012
- Humboldt Fellowship for Postdoctoral Research at the MPI of Biochemistry, Martinsried, 2011-2012
- CU-ADVANCE faculty development grant, 2011
- William Nichols Findley Prize: Best research paper by CU Applied Physics Grad Student, 2010
- Applied Materials Graduate Fellowship, 2005-2009
- Eric Samuel Scholarship Award, 2008
- Distinguished Scholar Award, Microanalysis Society, 2007
- International Microscopy Congress (IMC16) Scholarship Award, 2006
- Fulbright Travel Fellowship supporting studies at NC State University, Raleigh, NC, 2002
- Erasmus Fellowship supporting studies at Luleå University of Technology, Sweden, 2001