

Experience

Humboldt-Universität zu Berlin, Professor Christoph Koch

BERLIN, GERMANY

Postdoctoral Researcher, Structure Research and Electron Microscopy group

Sept. '18 – Dec. '21

I am currently in a postdoctoral position under Professor Christoph Koch and Dr. Wouter Van den Broek. My work has focused on improving nanobeam electron diffraction (NBED) ptychography, with the eventual goal to perform it during *in situ* experimentation on electronic and beam sensitive materials. The final goal is to observe and understand dynamic processes in these materials. In doing so, I will be developing *in situ* methods for these systems, as well as improving algorithmic techniques to control the microscope and analyze the collected diffraction data, with the goal of developing new experimental capabilities with regards to these systems and the electron microscope. A second thrust of this postdoc is to apply the latest EELS techniques *in situ* on our new Nion HERMES STEM.

U. C. Berkeley, Professor Andrew Minor

BERKELEY, CA

Ph.D. Student, Materials Science and Engineering

Aug. '13 – Aug. '18

I was one of the primary researchers advancing the field of scanning NBED (also known as 4D-STEM) with regards to both the experimental technique and image analysis algorithm development in order to elucidate structure-property relationships in structural materials *in situ*. My research focused on large field of view strain mapping of dislocations *in situ* and the application of NBED to the analysis of bulk metallic glasses and high entropy alloys. Previous projects included analyzing deformation processes in alloyed aluminum and the development and characterization of a novel TEM sample preparation technique. This research has spanned the various length scales, from the nano-level using *in situ* TEM experimentation to bulk mechanical testing. All work was performed at the National Center for Electron Microscopy (NCEM) at Lawrence Berkeley National Laboratory.

Mentor, Science Undergraduate Laboratory Internships

Apr. '17 – Aug. '17

Served as a graduate student mentor to an undergraduate student. Worked with a professor as well as a staff scientist to develop her skills at electron microscopy, data processing, and MATLAB. Together, successfully improved NCEM's amorphous materials characterization capabilities.

General Motors (Research and Development)

DETROIT, MI

Light Metal Systems Intern

Aug. '16 – Nov. '16

Performed microstructural and chemical validations using a variety of TEM, SEM and STEM experiments on several novel automotive sheet and extruded aluminum alloys to verify the suppliers were delivering acceptable materials.

Light Metal Systems Intern

May '14 – Aug. '14

Researched the microstructural phenomena responsible for work-hardening and toughening in 5xxx and 6xxx series aluminums. This involved developing state of the art experimental procedures on the JEOL 2100F S/TEM as well as the training of R&D scientists in the techniques I brought to General Motors.

U. C. Berkeley, Department of Materials Science and Engineering

BERKELEY, CA

Graduate Student Instructor

Jan. '14 – May '14

Taught a graduate level transmission electron microscopy class (MSE 241). Taught students of all ages and skills, including many senior students. Required thorough knowledge of both TEM theory and practice. Received a 4.91/5 rating in the end of semester course evaluations.

U. C. Berkeley, Professor Andrew Minor

BERKELEY, CA

Research Assistant

Aug. '12 – May. '13

Developed and performed micromechanical tests on samples of unique geometry.

Research Assistant

Aug '11 – May '12

Helped research novel cryogenic focused ion beam techniques as well as helped develop the necessary sample preparation methods.

U. C. San Diego, Professor Kenneth Vecchio

SAN DIEGO, CA

Research Assistant

May '12 – Aug. '12

Performed significant research on the thermomechanical processing of dual-phase steels including mechanical testing and x-ray diffraction to study processing effects on microstructure, strength, hardness, and composition.

Research Assistant

May '11 – Aug. '11

Analyzed a range of fiberglass and epoxy composites utilizing a variety of dynamic mechanical analysis and thermogravimetric analysis experiments to research the feasibility and effectiveness of using carbon nanotubes as a stiffening agent.

Education

University of California, Berkeley

BERKELEY, CA

Doctor of Philosophy in Materials Science and Engineering

2013 – 2018

Dissertation title: *in situ* Deformation Studies with Scanning Nanobeam Electron Diffraction

University of California, Berkeley

BERKELEY, CA

Master of Science in Materials Science and Engineering

2013 – 2015

Thesis title: Evaluation of neon focused ion beam milling for TEM sample preparation

University of California, Berkeley

BERKELEY, CA

Bachelor of Science in Materials Science and Engineering

2009 – 2013

Teaching

- MSE 241 – Transmission Electron Microscopy laboratory, UC Berkeley (graduate level hands on course)
 - CP 1 – Computational Physics 1, Humboldt Universität zu Berlin (undergraduate level, introduction to scientific Matlab and Python)
-

Technical Skills

Electron microscopy: Highly qualified using state-of-the-art transmission electron microscopes of all types, including the use of high framerate pixelated detectors and spectroscopy (EDS). Very experienced using JEOL, ThermoFisher (FEI), and Nion microscopes, including independent use on the doubly-aberration corrected TEAM I microscope at the National Center for Electron Microscopy. Experience running both *in situ* experiments in a variety of implementations, as well as nanobeam electron diffraction experiments, often simultaneously. Current research includes combining customized scripting of microscope acquisition parameters, advanced electron energy loss spectroscopy (EELS) and ptychographic methods.

Significant experience using scanning electron microscopes (SEM) and focused ion beams (FIB) for sample characterization and fabrication, including both traditional Ga FIBs as well as the Orion NanoFab, a He/Ne gas field ion source (GFIS) beam. The SEM characterization methods include novel electron backscattered diffraction (EBSD)-based techniques as well as *in situ* deformation.

Significant experience writing code to automate image analysis, including working with large datasets (>1TB) in both MATLAB and Python.

Other technical skills: x-ray diffraction, mechanical testing (tensile, compressive, hardness, micro and nano-indentation), dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), differential thermal analysis (DTA), cryogenic TEM sample preparation and handling procedures, data analysis, atom force microscopy, lathe and mill machining, standard metallurgical sample preparation techniques (arc melting, annealing, thermomechanical forming, polishing/etching for microstructure retrieval)

Computer Skills

Advanced: MATLAB, Python, L^AT_EX, Git, Adobe Illustrator, Adobe Lightroom, Adobe CameraRAW, Microsoft Office

Intermediate: MATHEMATICA, Bash scripting, Slurm, KaleidaGraph, OpenOffice, Adobe Photoshop, Adobe Premiere Pro, Computer Hardware and Assembly

Service and Recognition

- Nine invited talks (indicated below)
 - Organizer, “Multimodal *in situ* Characterization of Hard/Soft Materials Across Interfaces and Multiple Scales, Parts I & II”, a symposium at the Molecular Foundry User Meeting 2018.
 - Organizer, “*in situ* TEM of nanoscale materials and electronic devices for phase transformation studies”, a symposium at the Microscopy and Microanalysis (M&M) 2019 meeting.
 - Advising: two PhD students, and several bachelor students
-

Interests

In any order: volleyball, kitesurfing, surfing, photography, cycling, scuba diving, cars, sailing, live music

Publications, Presentations and Talks

Journal Articles

1. Allen, F. I., **Pekin, T. C.** & Minor, A. M. Fast sub-nanometer grain mapping by 4D-STEM. *In preparation* (May 2020).
2. Casalena, L., Gao, Y., **Pekin, T. C.**, Gammer, C., Ciston, J., Minor, A. M., Ophus, C., Noebe, R. D., Wang, Y. & Mills, M. J. Characterization of precipitate-matrix interaction in $\text{Ni}_{50.3}\text{Ti}_{29.7}\text{Hf}_{20}$ and $\text{Ni}_{45.3}\text{Ti}_{29.7}\text{Pd}_5\text{Hf}_{20}$ shape memory alloys. *In preparation* (May 2020).
3. Schloz, M., **Pekin, T. C.**, Chen, Z., Van den Broek, W., Muller, D. A. & Koch, C. T. Regularized optimization for ptychography. *In preparation* (Apr. 2020).
4. Savitzky, B. H., Hughes, L. A., Zeltmann, S. E., Brown, H. G., Zhao, S., Pelz, P. M., Barnard, E. S., Donohue, J., DaCosta, L. R., **Pekin, T. C.**, *et al.* py4DSTEM: a software package for multimodal analysis of four-dimensional scanning transmission electron microscopy datasets. *arXiv preprint arXiv:2003.09523* (Mar. 2020).
5. Deng, Y., Zhang, R., **Pekin, T. C.**, Gammer, C., Ciston, J., Ercius, P., Ophus, C., Bustillo, K., Song, C., Zhao, S., *et al.* Functional Materials Under Stress: In Situ TEM Observations of Structural Evolution. *Advanced Materials* (Nov. 2019).
6. **Pekin, T. C.**, Ding, J., Gammer, C., Ozdol, B., Ophus, C., Asta, M., Ritchie, R. O. & Minor, A. M. Direct measurement of nanostructural change during *in situ* deformation of a bulk metallic glass. *Nature Communications* **10**, 2445 (June 2019).
7. Gammer, C., Ophus, C., **Pekin, T. C.**, Eckert, J. & Minor, A. M. Local nanoscale strain mapping of a metallic glass during *in situ* testing. *Applied Physics Letters* **112**, 171905 (Apr. 2018).
8. **Pekin, T. C.**, Gammer, C., Ciston, J., Ophus, C. & Minor, A. M. In situ nanobeam electron diffraction strain mapping of planar slip in stainless steel. *Scripta Materialia* **146**, 87–90 (Nov. 2017).
9. **Pekin, T. C.**, Gammer, C., Ciston, J., Minor, A. M. & Ophus, C. Optimizing disk registration algorithms for nanobeam electron diffraction strain mapping. *Ultramicroscopy* (Jan. 2017).
10. **Pekin, T. C.**, Allen, F. I. & Minor, A. M. Evaluation of neon focused ion beam milling for TEM sample preparation. *Journal of Microscopy* **264**, 59–63 (Oct. 2016).

Presentations and Talks

1. **Pekin, T. C.** 4DSTEM for analysis of amorphous materials. **Invited.** Institute for Materials Physics, University of Münster, Münster, Germany, Nov. 2019.
2. **Pekin, T. C.** Novel TEM focused ion beam fabrication techniques. **Invited.** Department of Materials Science, Sungkyunkwan University, Nanjing, China, Nov. 2019.
3. **Pekin, T. C.** Probing local properties in crystal and amorphous materials using advanced (S)TEM techniques. Department seminar, **Invited.** Department of Materials Science, Shanghai Jiao Tong University, Shanghai, China, Nov. 2019.
4. **Pekin, T. C.**, Gammer, J. C., Ophus, C., Ritchie, R. O. & Minor, A. M. Four Dimensional Scanning Transmission Electron Microscopy during the *in situ* Annealing of a CuZrAl Bulk Metallic Glass in *in situ* TEM Characterization of Dynamic Processes During Materials Synthesis and Processing (M&M, Portland, OR, USA, Aug. 2019).
5. **Pekin, T. C.**, Gammer, J. C., Ophus, C., Ritchie, R. O. & Minor, A. M. Four Dimensional Scanning Transmission Electron Microscopy during the *in situ* Annealing of a CuZrAl Bulk Metallic Glass in *in-situ*, Environmental, Time-resolved Electron Microscopy (MC 2019, Berlin, DE, Aug. 2019).
6. **Pekin, T. C.**, Ding, J., Gammer, C., Ozdol, B., Ophus, C., Asta, M., Ritchie, R. O. & Minor, A. M. Nanobeam Electron Diffraction and *in situ* Deformation of CuZrAl Bulk Metallic Glass in the STEM in Nanobrucken 2019: A Nanomechanical Testing Conference **Invited** (Berlin, Germany, Feb. 2019).
7. **Pekin, T. C.**, Ding, J., Gammer, C., Ozdol, B., Ophus, C., Asta, M., Ritchie, R. O. & Minor, A. M. Mapping local strain and order with nanobeam diffraction during *in situ* deformation of bulk metallic glasses in Four-dimensional Scanning Transmission Electron Microscopy (4D-STEM): From Scanning Nanodiffraction to Ptychography and Beyond (M&M, Baltimore, MD, USA, Aug. 2018).
8. **Pekin, T. C.**, Ding, J., Gammer, C., Ozdol, B., Ophus, C., Asta, M., Ritchie, R. O. & Minor, A. M. Mapping local strain and order with nanobeam diffraction during *in situ* deformation of bulk metallic glasses in Advanced Characterization of Deformation Processes II (ICSMA, Columbus, OH, USA, July 2018).

9. **Pekin, T. C.** *In situ nanobeam electron diffraction and analysis* **Invited**. Center for Integrated Nanotechnology, Sandia National Laboratory, Albuquerque, NM, USA, Mar. 2018.
10. **Pekin, T. C.** *In situ scanning nanobeam electron diffraction experimentation and analysis* in *Advanced Light Source User Meeting* **Invited** (Berkeley, CA, USA, Oct. 2017).
11. **Pekin, T. C.** *Diffraction pattern acquisition and analysis of 4D STEM datasets obtained from high speed cameras* in *Gatan Vendor Tutorial* **Invited** (M&M, St. Louis, MO, USA, Aug. 2017).
12. **Pekin, T. C., Ophus, C., Ciston, J., Gammer, C. & Minor, A. M.** *In situ strain mapping of planar slip in 321 stainless steel* in *Nanomechanical Characterization of Materials using Microscopy and Microanalysis Techniques* (M&M, St. Louis, MO, USA, Aug. 2017).
13. **Pekin, T. C., Ophus, C., Ciston, J., Gammer, C. & Minor, A. M.** *Scanning Nanobeam Electron Diffraction of Planar Slip* in *Berkeley Titanium Workshop* **Invited** (Berkeley, CA, USA, July 2017).
14. **Pekin, T. C., Ophus, C., Ciston, J., Gammer, C. & Minor, A. M.** *In situ strain mapping of planar slip in 304 stainless steel* in *Berkeley Workshop on Micromechanics & Materials Behavior: Bridging the Gaps* **Invited** (Berkeley, CA, USA, Mar. 2017).
15. **Pekin, T. C., Ophus, C., Ciston, J., Gammer, C. & Minor, A. M.** *In situ strain mapping of planar slip in 304 stainless steel* in *Advanced Characterization Techniques for Quantifying and Modeling Deformation Mechanisms* (TMS, San Diego, CA, USA, Feb. 2017).
16. **Pekin, T. C., Allen, F. I. & Minor, A. M.** *Evaluation of neon focused ion beam milling for TEM sample preparation* in *Advances in FIB Instrumentation and Applications in Materials and Biological Sciences* **22** (M&M, Columbus, OH, USA, July 2016), 146–147.
17. **Pekin, T. C., Ciston, J., Gammer, C. & Minor, A. M.** *Nanoscale strain mapping during in situ deformation of annealed Al-Mg alloys* in *Advanced Scanning Diffraction: Mapping Functionality in Reciprocal Space at Nanometer Resolution* **22** (M&M, Columbus, OH, USA, July 2016), 522–523.