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Tristan Truttmann, Ph.D., P.E.

Senior Engineer | Materials Science and Electrochemistry
Menlo Park
ttruttmann@exponent.com

Professional Profile

Dr. Truttmann specializes in materials science, chemistry, and inferential statistics applied to technical innovation, reliability, and failure analysis. He combines microscopic insights from materials characterization with macroscopic insights from inferential statistics to identify the small features, dilute concentrations, and rare events that explain how products function and how they fail.

Electron Microscopy

Dr. Truttmann is an operator of Exponent's scanning electron microscopes (SEMs) and plasma focused ion beam (PFIB) in Menlo Park. He often uses the high resolution of SEM and elemental identification from energy-dispersive spectroscopy (EDS) to quickly discern products' structure and composition for intellectual property. Dr. Truttmann also uses SEM for fractography to determine the defects and stress conditions that lead to fracture in glasses, single crystals, and metals.

Dr. Truttmann uses FIBs to remove material in controlled patterns to "peer under the surface" of products, creating cross sections that can be imaged in situ to measure the thicknesses of coatings or the stackup of layered materials, and to prepare lamellae for transmission electron microscopy (TEM). Dr. Truttmann can also perform electron backscatter diffraction (EBSD) and transmission Kikuchi diffraction (TKD) to directly measure grain orientation and microstructure of polycrystalline solids.

Inferential Statistics & Reliability

Dr. Truttmann has applied inferential statistics to reliability and failure analysis, where data is often highly censored and questions are frequently open-ended. Dr. Truttmann uses a broad set of tools to address these challenges, and may use frequentist, Bayesian, multivariate, or heuristic approaches where appropriate. These tools have supported projects ranging from lithium-ion battery fire forecasting in electric vehicles to limiting the scope of consumer-product safety recalls by making sense of loosely correlated attribute data. In these projects, Dr. Truttmann emphasizes combining multiple information sources into comprehensible visualizations that accurately convey uncertainty and directly answer client questions.

Computer Vision & Artificial Intelligence

Dr. Truttmann has experience in computer vision analyzing SEM and X-ray images. With Python packages like scikit-image or OpenCV, he commonly applies image segmentation to extract particle size distributions from images. Dr. Truttmann also uses deep learning to make sense of large image data sets, using tools like Pytorch to create neural networks that learn feature correlations between images (or between images and other measurements). He also uses model interpretability tools like Captum to uncover and visualize these correlations. To generate the large image datasets necessary for meaningful

deep learning, Dr. Truttmann has designed and implemented high-throughput automated data acquisition and processing pipelines. Dr. Truttmann is an operator of Exponent's 2D X-ray system in Menlo Park, with which he has experience programing for automated image acquisition.

Intellectual Property

Dr. Truttmann has assisted clients in disparate intellectual property matters helping evaluate patent validity and product infringement for both plaintiffs and defendants. Dr. Truttmann has assisted clients in district court litigation, International Trade Commission (ITC) investigations, inter partes reviews (IPR), and ex parte reexaminations (EPR). Dr. Truttmann has applied this broad technical knowledge to IP projects involving lithium-ion batteries, solar cells, and recyclable packaging.

Semiconductor Growth, Characterization, & Device Fabrication

Dr. Truttmann received his Ph.D. from the University of Minnesota in 2023. During his Ph.D. research, Dr. Truttmann studied ultra-wide-bandgap semiconductors, materials with bandgaps exceeding 4 eV, making them transparent to visible light and capable of handling high voltages. His research included their growth, characterization, and use in transistors.

A large part of his research was dedicated to studying how deposition techniques and growth conditions can be tailored to a specific material and application. In particular, his research utilized hybrid molecular beam epitaxy (MBE), a high-vacuum vapor deposition technique sometimes described as a combination of traditional MBE and chemical vapor deposition (CVD). His research included the design and construction of two MBE systems customized with metal-organic precursor sources, oxygen plasma, in-situ electron diffraction, and an electron beam evaporator.

His choice of growth conditions was informed by his own materials characterization, which gave him hands-on experience in reflection high-energy electron diffraction (RHEED), high-resolution X-ray diffraction (XRD), atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), and van der Pauw Hall electron mobility measurements. His XRD work included the full suite of techniques required to evaluate thin-film epitaxy, thickness, and strain including specular coupled scans, rocking curves, azimuthal scans, reciprocal space maps (2D and 3D), pole figures, and reflectivity. Dr. Truttmann also received hands-on experience in the cleanroom fabricating transistors.

At Exponent, Dr. Truttmann continues to apply his knowledge of semiconductors and devices to address client needs. Dr. Truttmann has conducted technical due diligence for venture capital investments in hard-tech startups, and performed failure analysis on consumer electronics displays.

Academic Credentials & Professional Honors

Ph.D., Materials Science and Engineering, University of Minnesota, 2023

B.A., Chemistry, Macalester College, 2017

University of Minnesota Doctoral Dissertation Fellowship, 2021-2022

Licenses and Certifications

Professional Engineer Metallurgical, California, #2057

Professional Affiliations

Member of the Phi Beta Kappa Honor Society

Languages

Mandarin Chinese

Publications

Truttmann T. Hybrid molecular beam epitaxy of ultra-wide band gap semiconductors. PhD Thesis 2023.

Truttmann T, Zhou J, Lu I, Rajapitamahuni A, Liu F, Mates T, Berndardi M, Jalan B. Combined experimental-theoretical study of electron mobility-limiting mechanisms in SrSnO3. Commun. Phys. 2021; 4(241).

Truttmann T, Liu F, Barriocanal J, James R, Jalan B. Strain relaxation via phase transformation in SrSnO3. ACS Appl. Electron. Mater. 2021; 3(3).

Truttmann T, Prakash A, Yue J, Mates T, Jalan B. Dopant solubility, and charge compensation in la-doped SrSnO3 films. Appl. Phys. Lett. 2019; 115(15).

Yoon H, Truttmann T, Liu F, Matthews B, Choo S, Su Q, Saraswat V, Manzo S, Arnold M, Bowden M, Kawasaki J, Koester S, Spurgeon S, Chambers S, Jalan B. Free-standing epitaxial SrTiO3 nanomembranes via remote epitaxy using hybrid molecular beam epitaxy. Science Advances 2022; 8(51). (Equally Contributing Author)

Liu F, Truttmann T, Lee D, Matthews B, Laraib I, Janotti A, Spurgeon S, Chambers S, Jalan B. Hybrid molecular beam epitaxy of gegermanium-based oxides. Communications Materials 2021; 3(69). (Equally Contributing Author)

Liu F, Golani P, Truttmann T, Evangelista I, Smeaton M, Bugallo D, Wen J, Manjeshwar A, May S, Kourkoutis L, Janotti A, Koester S, Jalan B. Doping the undopable: hybrid molecular beam epitaxy growth, n-type doping, and field-effect transistor using CaSnO3. ACS Nano 2023; 17(17).

Chambers S, Lee D, Yang Z, Huang Y, Samarakoon W, Zhou H, Sushko P, Truttmann T, Wangoh L, Lee T, Gabel J, Jalan B. Combining in-situ and ex-situ measurements to probe electronic dead layers in homoepitaxial n-SrTiO3(001) films. APL Materials 2022; 10(7).

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Yue J, Ayino Y, Truttmann T, Gastiasoro M, Persky E, Khanukov A, Lee D, Thoutam L, Kalisky B, Fernandes R, Pribiag V, Jalan B. Anomalous transport in high-mobility superconducting SrTiO3 thin films. Sci. Adv. 2022; 8(21).

Lee D, Liu F, Truttmann T, Chambers S, Jalan B. Stoichiometry-dependent surface electronic structure of SrTiO3 films grown by hybrid molecular beam epitaxy. Appl. Phys. Lett. 2022; 121(16).

Thoutam L, Truttmann T, Rajapitamahuni A, Jalan B. Hysteretic magnetoresistance in a non- magnetic SrSnO3 film via thermal coupling to dynamic substrate behavior. Nano Lett. 2021; 21(23).

Nunn W, Truttmann T, Jalan B. A review of molecular beam epitaxy of wide bandgap complex oxide semiconductors. J. Mater. Res. 2021; 36:4846–4864. (Invited Review Article)

Nunn W, Yue J, Manjeshwar A, Rajapitamahuni A, Truttmann T, Jalan B. Novel synthesis approach for stubborn metals and metal oxides. Proc. Natl. Acad. Sciences 2021; 118(32):e2105713118.

Chaganti V, Truttmann T, Liu F, Jalan B, Koester S. Optimizing ohmic contacts to Nd-doped n-type SrSnO3. Phys. Lett. 2021.

Wen J, Chaganti SK, Truttmann T, Liu F, Jalan B, Koester S. SrSnO3 metal-semiconductor field-effect transistor with GHz operation. IEEE Electron Device Lett. 2021; 42(1).

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Wang T, Prakash A, Dong Y, Truttmann T, Bucsek A, James R, Fong D, Kim J-W, Ryan P, Zhou H, Birol T, Jalan B. Engineering SrSnO3 phases and electron mobility at room temperature using epitaxial strain. ACS Appl. Mater. & Interfaces 2018; 10(50).

Kyasa S, Meier R, Pardini R, Truttmann T, Kuwata K, Dussault P. Synthesis of ethers via reaction of carbanions and monoperoxyacetals. J. Org. Chem. 2015; 80(24).

Presentations

Truttmann T, Zhou J, Lu I, Rajapitamahuni A, Liu F, James R, Bernardi M, Jalan B. Hybrid molecular beam epitaxy and electronic transport of alkaline earth stannates. APS March Meeting, Chicago, IL, 2022.

Truttmann T, Zhou J, Lu I, Rajapitamahuni A, Liu F, James R, Bernardi M, Jalan B. MBE growth, defect and electronic transport in alkaline earth stannates. Invited Talk at Electronic Materials and Applications, Orlando, FL, 2022.

Truttmann T, Zhou J, Lu I, Rajapitamahuni A, Liu F, James R, Bernardi M, Jalan B. Perovskite oxide as ultra-wide bandgap materials for transparent electronics. IPRIME Summer Meeting, Minneapolis, MN, 2021.

Truttmann T, Zhou J, Lu I, Rajapitamahuni AK, Liu F, James R, Bernardi M, Jalan B. Strontium stannate as an ultra-wide bandgap semiconductor. APS March Meeting, Boston, MA, 2021.

Truttmann T, Yue J, Thoutam L, Prakash A, Wang T, Liu F, Bucsek A, Dong Y, Mates T, Fong D, Kim J-W, Ryan P, Zhou H, Birol T, James R, Jalan B. MBE growth and doping of ultra-wide gap perovskite SrSnO3. MRS Fall Meeting, Boston, MA, 2020.

Truttmann T, Liu F, Prakash A, Yue J, Mates T, Jalan B. Ultra-wide bandgap, transparent perovskite oxides for power electronics. IPRIME Summer Meeting, Minneapolis, MN, 2020.

Truttmann T, Liu F, Prakash A, Yue J, Mates T, Jalan B. Radical-based MBE growth, chemical doping, and electronic transport in SrSnO3 films. APS March Meeting, Denver, CO, 2020.

Truttmann T, Wang T, Prakash A, Yue J, Dong Y, Bucsek A, Mates T, James R, Fong D, Kim J, Ryan P, Zhou H, Birol T, Jalan B. Structure, dopant solubility, and transport in la- doped tetragonal SrSnO3 stabilized with strain. American Vacuum Society Summer Meeting, St. Paul, MN, 2019.

Truttmann T, Wang T, Prakash A, Yue J, Dong Y, Bucsek A, Mates T, James R, Fong D, Kim J, Ryan P,

Zhou H, Birol T, Jalan B. Structure, dopant solubility, and transport in la-doped tetragonal SrSnO3 stabilized with strain. IPrime Summer Meeting, Minneapolis, MN, 2020.

Truttmann T, Wang T, Prakash A, Yue J, Yun H, Birol T, Mkhoyan A, Jalan B. MBE growth, defects, & doping in strained SrSnO3. International Conference for Defects in Semiconductors, Seattle, WA, 2019.

Truttmann T, Subramanian G. Ab initio monte carlo simulations of military contaminants binding to cellulose and its derivatives. ACS Spring National Meeting, San Francisco, CA, 2017.

Truttmann T, Kuwata K. quantum chemical studies of a new pathway to ethers. MU3C Summer Conference, Chicago, IL, 2015.