UC SANTA BARBARA MATERIALS

Design | Synthesize | Characterize | Predict

WINTER 2017

Professor Fred Lange
1939 - 2010

2016 PHD DISSERTATIONS

"High Power High Efficiency Semipolar InGaN Light Emitting Devices for Solid State Lighting" by **Daniel Becerra**

"Single Molecule Studies of Polyelectrolyte Structure" by **John Berezney**

"Understanding and Engineering Two-Dimensional Electron Gases in Complex Oxides" by **Lars Bjaalie**

"Laser Based Phosphor Converted Solid State White Light Emitters" by **Michael Cantore**

"Modifying Membrane Properties with Conjugated Oligoelectrolytes and Elucidating the Charge Transfer Mechanisms" by **Chelsea Catania**

"Highly Scaled High Dielectric Constant Oxides on III-V CMOS with Low Interface Trap and Low Leakage Densities" by **Varistha Chobpattana**

"Biphasic Thermoelectric Materials Derived from the Half-Heusler/Full-Heusler System Ti-Ni-Sn" by **Jason Douglas**

"Vertical Unipolar Transport through Isotype III-Nitride Heterostructures by Molecular Beam Epitaxy" by **Micha Fireman**

"Tuning Electrostatic Interactions in Confined Soft Matter" by **Matthew Gebbie**

"Understanding Charge Transport in Polymers for Thermoelectric Applications" by **Anne Glaudell**

"Processing and Characterization of Titanium Dioxide Based Resistive Switches" by **Brian Hoskins**

"Design and Characterization of High-strength Bond Coats for Improved Thermal Barrier Coating Durability" by **David Jorgensen**

"Enhancing Bioelectrochemical Conversion: Molecular Modifications for Amplified Transmembrane Electron Transfer" by **Nathan Kirchhofer**

"Electrically Injected and Optically Pumped III-Nitride Devices for Polarized White Light Emission" by **Stacey Kowsz**

"Epitaxy and Device Design for High Efficiency Blue LEDs and Laser Diodes" by **Leah Kuritzky**

"Growth Development of III-Nitrides for Electronic Devices by Molecular Beam Epitaxy" by **Erin Kyle**

"Pushing the Envelope of Magnetic Tweezer Resolution" by **Bob Lansdorp**

"III-Nitride Vertical-Cavity Surface-Emitting Lasers Growth, Fabrication, and Design of Dual Dielectric DBR Nonpolar VCSELs" by **John Leonard**

"Phase Equilibria and Toughness of Zirconia-Based Thermal Barrier Coatings" by **Chandra Macauley**

"Real-time Measurement, Analysis, and Control in Microfluidic Systems for Personalized Medicine and Designer Materials" by **Peter Mage**

"High-Temperature Growth of Gallium Nitride Using the Ammonothermal Method with Ammonium Chloride Mineralizer" by **Thomas Malkowski**

"Simulating Quantum Chemical Dynamics with Improved Superconducting Qubits" by **Anthony Megrant**

"Tunable Dielectric Response, Resistive Switching, and Unconvention Transport in SrTiO3" by **Evgeny Mikheev**

"Texture Evolution During Thermomechanical Processing in Rare Earth Free Magnesium Alloys" by **Victoria Miller**

"Plastic Anisotropy and Kink Band Formation in Fine Grained Copper-Niobium Multilayers Produced by Accumulative Roll Bonding" by **Thomas Nizolek**

"High Power Blue Laser Diodes on Semipolar (2021) GaN Substrates" by **Arash Pouhashemi**

"Rejuvenation of Ni-Base Superalloys GTD444 and René N5" by **Luke Rettberg**

"Antimonide-Based Compound Semiconductors for Quantum Computing" by **Borzoyeh Shojaei**

"Using Photoredox Catalysis to Expand Atom Transfer Radical Polymerizations and Radical Dehalogenations" by **Nicolas Treat**

"Sodium Flux Growth of Bulk Gallium Nitride" by **Paul Von Dollen**

"Bioinspired Assembly of Functional Polymers into Well-Defined Materials" by **Cynthia Wang**

"The Character, Stability and Consequences of Mn-Ni-Si Precipitates in Reactor Pressure Vessel Steels" by **Peter Wells**

"Elucidating the Mechanism of Bond Coat Cavitation under CMAS-infiltrated Thermal Barrier Coatings" by **Kaylan Wessels**

"Hybrid MOCVD/MBE III-Nitride Tunnel Junctions" by **Benjamin Yonkee**

"Characterizing Local Structure in Complex Oxides with Quantitative Scanning Transmission Electron Microscopy" by **Jack Zhang**

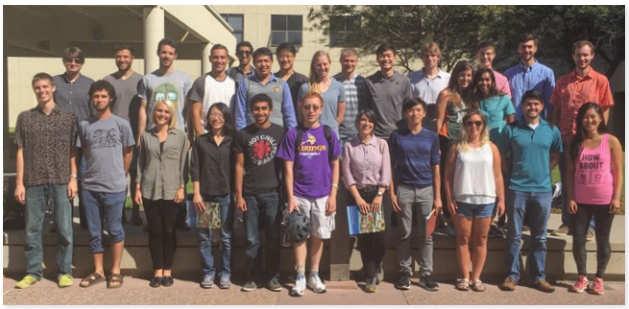
MATERIALS PHOTO AND IMAGE CONTEST

Overall Winner: *Polarized Light Micrograph of Cu-Nb Nanolaminate that Deformed by Kink Band Formation* — Tom Nizolek

The 2016 Materials Department Photo and Image Contest, held to honor the imaging and visualization necessary for materials research, encouraged graduate students, researchers, and staff to submit entries in five categories: experimental, lab equipment, people and events, scenic, and computer illustrated.

Winners of the contest received certificates to local Santa Barbara restaurants and treats from local wineries and chocolatiers and were announced at the Winter Retreat.

MATERIALS WELCOMES NEW GRADUATE STUDENTS



2016 Incoming Students

In September, 29 students from top science and engineering programs joined the Materials Department. Five students received NSF Graduate Student Fellowships, including one who also received the prestigious Hertz Fellowship.

In addition to their academic accomplishments, the students' extracurricular interests range from fencing competitively to performing on the flying trapeze to playing musical instruments. The Department is eager to see the scientific and personal growth and accomplishments of these new students over the next few years.

FRED LANGE HONORARY LECTURE SERIES

M. Lou Balmer-Millar
General Manager
Caterpillar, Inc.

Fred Lange distinguished himself as an educator and scientist with significant contributions towards advancing materials science in the areas of powder and solution processing, fracture mechanics and damage-tolerant ceramics. In his accomplished career, he published over 300 papers, was granted 32 patents, earned countless awards, and advised over 30 Ph.D. students.

Fred was one of the visionaries that established and then grew the Materials Department at UCSB. He and his colleagues that started the department infused it with a culture of boundary-less collaboration, constructive debate, and cross-functional exploration. Out of this environment grew generations of students that carried this collaborative culture with them in their careers, further amplifying Fred's positive impact.

We remember him as a caring and challenging mentor who helped to shape us into the professionals we would become. He was quick with a hearty laugh, a word of encouragement, and a story. He challenged us to achieve success beyond our own expectations, coached and supported us when we encountered obstacles, promoted our accomplishments, and cared about us as if we were family.

I can think of no better way to honor his legacy than by creating an opportunity that brings together the next generations of inquisitive minds to explore and debate the frontiers in materials science. This lecture series is a most fitting tribute to our distinguished professor and dear friend, Fred Lange.

Craig Hillman
CEO of DfR Solutions

As I am sure you are aware, our alma mater, the UCSB Materials Department, continues to build upon its already stratospheric reputation. Just within this past year, it was ranked No. 2 among US Materials programs by US News and World Report and ranked No. 4 in Citations per Paper among world Materials programs by QS World University Rankings. This academic success is on top of the amazing number of startups constantly being generated, including Next Energy Technologies, Fluency Lighting Technologies, and Crystalline Mirror Solutions.

All of these achievements can sometimes overshadow the realization that our alma mater resides in the perpetually underfunded public University of California. Its continued ability to attract top tier talent rests on our willingness to give back to the institution that gave so many of us the knowledge and contacts to become the successes we are today.

The Department needs your help in supporting a new Lecture Series in the name of my former advisor and mentor, the late Professor Fred Lange. The Fred Lange Honorary Lecture Series was created to invite exceptional young faculty and outstanding young researchers to give seminars to Materials graduate students.

These kinds of interactions are so critical in building knowledge and connections, but are often starved of funds by the restrictions implicit in state and federal contracts. Please join me in continuing to make UCSB Materials the special place it has always been by making a donation to this small, but important initiative.

Professor George Franks
University of Melbourne

I am delighted to hear that the Materials Department is endowing the Fred Lange Honorary Lecture Series.

Fred was my Ph.D. advisor between '92 and '97. His guidance and inspiration helped me to become successful. Fred made a special effort to introduce me to the most talented people working in the field when we were at conferences, although I was "only" a Ph.D. student at the time. One of these people was David Boger from the University of Melbourne, for whom I went to work after completing my Ph.D., leading to my career in Australia. Fred took a sabbatical to Melbourne around 2006 and returned twice over the following years. He provided support and advice, and we remained in close contact until he passed away in 2010.

Fred's endearing personality and his sharp academic intellect make him a person of outstanding notoriety. He influenced his students, and an entire generation of researchers in the fields of ceramic powder processing and structural ceramics. As a mentor, supervisor and teacher, Fred's unwavering support allowed his students to grow, and achieve the success that we enjoy today. For this we are forever grateful.

If you would like to donate to the Fred Lange Honorary Lecture Series, use the enclosed form and envelope, or visit giveucsb.com/materials.htm. Thank you for your generosity and support. For questions, please email materials@engineering.ucsb.edu or call (805)893-4362.

NEW CLASS OF MATERIALS CONTINUES TRADITION OF MATERIALS INNOVATION with Prof. Susanne Stemmer

Winning the National Security Science and Engineering Faculty Fellowship, (recently renamed the Vannevar Bush Faculty Fellowship), has allowed Prof. Susanne Stemmer to embark on a new scientific journey. Previously, much of Prof. Stemmer's research focused on complex oxides. In the Vannevar Bush Faculty Fellowship project, Prof. Stemmer builds on the tradition of developing new classes of electronic materials, for which the UCSB Materials Department is known. In this case, the new class of materials is three-dimensional (3D) Dirac materials.

Prof. Stemmer develops 3D Dirac materials, discovered only a few years ago, using molecular beam epitaxy (MBE). Prof. Stemmer grows thin films of these materials in an MBE system and plans to take advantage of their very unique electronic structure. Using heterostructure engineering to control their unique topological electronic states, Prof. Stemmer anticipates tuning the unique phenomena, not found in any other class of materials, of the thin films.

The control achieved using heterostructure engineering enables new opportunities and device paradigms for spintronics, sensors, and high-speed electronics. Because the physics is unique, 3D Dirac materials are exceptionally interesting to synthesize and characterize. For Prof. Stemmer, studying a new class of materials, a tradition that defines the success of MBE at UCSB, is very exciting.

IMPACT ACROSS THE MATERIALS SPECTRUM with Prof. Chris Van de Walle

When Prof. Chris Van de Walle was a graduate student at Stanford, computational materials research was in its infancy. Today, it is a branch of science impacting every aspect of materials research, connecting seemingly unrelated fields and problems. In 2016, Prof. Van de Walle was inducted into the National Academy of Engineering for his impact on the field.

Prof. Van de Walle's contributions include a methodology to calculate recombination processes in LEDs that can identify specific defects detrimental to LED efficiency. During that process, new physics was discovered, which now enables the study of different problems, such as in UV light emitters and scintillators.

He also explores energy conservation and renewable energy, with a particular interest in creating breakthroughs in energy storage. Hydrogen, which has been shown to be a highly efficient energy carrier, motivates much of the fundamental materials research Prof. Van de Walle conducts.

Prof. Van de Walle credits his graduate students and postdoctoral researchers for progressing the science in these varied research areas. He encourages his group members to have a broad overview of theoretical, computational, and experimental research to truly impact technology and society when they leave UCSB.

RETHINKING THERMOELECTRICS
with Profs. Rachel Segalman and Michael Chabinyc

Thermoelectric materials can interconvert thermal and electrical energy; an input of a temperature differential generates electrical power, and an input of electrical power generates a difference in temperature. Conventional thermoelectric devices are made with inorganic materials and are used in space probes as a power source, in simple refrigerators, and in devices for precise temperature control. Emerging applications for thermoelectrics include low-grade heat recovery and energy harvesting for sensors, but are currently limited by the ability to scale-up materials and the demands for manufacturing them in the necessary physical form.

Over the past five years, the performance of organic thermoelectrics has been rapidly improving and is reaching levels useful for applications. At UCSB, Profs. Rachel Segalman and Michael Chabinyc conduct basic energy science to learn more about organic thermoelectrics.

Polymers have intriguing properties as thermoelectrics. They have high electrical conductivities and low thermal conductivities –properties that are highly desirable for thermoelectrics. However, the magnitude of voltage resulting from a temperature bias,the Seebeck coefficient, and how it scales with electrical conductivity is difficult to predict. Additionally, the Seebeck coefficient can be influenced by ionic conductivity, particularly in soft materials. The role of ionic conductivity is a nearly unexplored space, so Profs. Segalman and Chabinyc are investigating how ionic and electronic currents are coupled in organic thermoelectric materials and how to leverage these effects towards higher performance materials.

Perhaps in the near future, organic thermoelectrics can convert the heat from hot water flowing through pipes into electricity or use electricity to heat or cool fabric for medical applications. After all, there is a huge amount of power to be captured at 200C and below, the temperature realm at which polymers are stable. And who better to usher in the future of thermoelectrics through basic science research than Profs. Segalman and Chabinyc.

LIFE IN THE LABORATORY with Dakota Hanemann-Rawlings and Elayne Thomas

Dakota Hanemann-Rawlings, a first-year Chemical Engineering graduate student, and Elayne Thomas, a second-year Materials graduate student, are the dynamic duo synthesizing and characterizing the thermoelectric polymers, respectively. They are excited to investigate basic scientific principles and to discover new pathways to alternative energy.

FACULTY AWARDS

Prof. Larry Coldren
National Academy of Inventors

Prof. Shuji Nakamura
Asian Award for Outstanding Achievement in Science and Technology
Election to Academia Sinica

Prof. Robert Odette
JOM Award
Fellow of the Minerals, Metals, and Materials Society

Prof. James Speck
National Academy of Inventors

Prof. Susanne Stemmer
National Security Science and Engineering Faculty Fellow
Racheff Award Lecture, University of Illinois at Urbana-Champaign

Prof. Galen Stucky
Spirit of Innovation Award

Prof. Chris Van de Walle
Elected to the National Academy of Engineering

A WELL DESERVED HONOR

THANK YOU FOR YOUR SUPPORT!

The Materials Department would like to thank the following for their generous gifts:

Bill & Dorothy Adler

Michael Crowell & Katherine Page

Richard Gamble & Kristin Meinert

Khalid & Jennifer Hattar

Mason & Dorice Hu

Daniel & Jessica Krogstad

Carlos & Lubella Levi

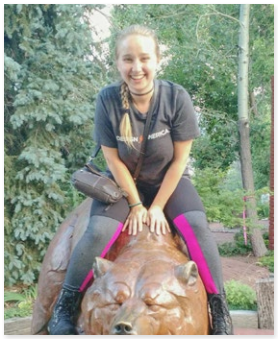
James Millar & Lou Balmer-Millar

Karen Sohn

Ben Yen

The Department would also like to thank James Rogers and Apeel Sciences for supporting the 2016 Materials Department Photo & Image Contest.

James Rogers



"IT IS SO IMPORTANT AS A GRADUATE STUDENT TO MAKE CONNECTIONS WITH THE PEOPLE IN YOUR FIELD AND ESTABLISH YOURSELF AS PART OF THE RESEARCH COMMUNITY."

- Emily Levin, Materials Graduate Student

The Graduate Student Development Fund was established to help attract the best and brightest students by offering exceptional development experiences beyond the laboratory and classroom, including international research exchanges, internships, travel to conferences, and leadership development experiences.

In spite of their importance, these activities cannot be supported by conventional research contracts. Join the Materials Department in providing excellent opportunities for our students by giving to the Graduate Student Development Fund. Together, we can create today's leaders for tomorrow's materials.

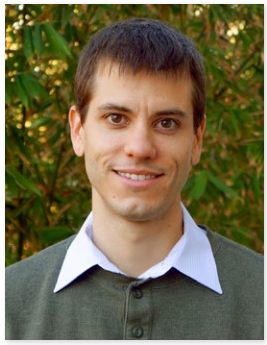
Please consider supporting the professional growth and development of Materials graduate students by giving to the Materials Department's Graduate Student Development Fund using the enclosed form and envelope, or by visiting giveucsb.com/materials.htm. Thank you for your generosity and support. For questions, please email materials@engineering.ucsb.edu or call (805)893-4362.

NEW FACULTY

Scenery Winner — Brian Haidet

Professor Irene Beyerlein

Prof. Beyerlein joined the UCSB Mechanical Engineering and Materials faculty this past summer. Prof. Beyerlein's research focuses on the creation and design of advanced materials with unprecedented structural performance under extremes of strains, stress, and temperature. The research goals are to understand and predict how to design novel lightweight materials with strengths approaching their theoretical limits. The research advances high-throughput computational materials science and aims to uncover and understand key deformation mechanisms, to model and predict prevailing defect interactions with internal grain boundaries and interfaces, and to simulate manufacturing processes in order to design pathways for target micro- or nano-structures. Prof. Beyerlein joined the UCSB Engineering faculty from Los Alamos National Laboratory, where she was the co-Director of the Energy Frontier Research Center.



Assistant Professor Christopher Bates

Prof. Bates joined the Materials faculty in the Macromolecular and Biomolecular Materials research area in July. Prof. Bates' research sits at the intersection of chemistry, materials science, and physics, leveraging a variety of synthetic and physical experimental techniques to design, create, and probe the structure and properties of soft matter. Current endeavors span a variety of topics including polymer mesostructure and dynamics, energy storage and crystallization. The primary goal of Prof. Bates' research program is student development: nucleating and fostering internal motivation to learn through access to a world-class research environment. For Prof. Bates, the synergy between students, faculty, and departments is clearly reflected in the campus-wide quality of education and research. Prof. Bates came to UCSB from the California Institute of Technology, where he was a postdoctoral scholar.

Assistant Professor Kunal Mukherjee

Prof. Mukherjee joined the Materials faculty in November in the Electronic and Photonic Materials research area. Prof. Mukherjee is interested in synthesizing compound semiconductors for improved optoelectronic, imaging, and power generation devices. He plans to establish expertise in narrow band-gap semiconductor growth in the III-V and the lesser studied IV-VI material systems. These semiconductors will have application in detecting and emitting in the infrared as well as test beds for novel physical phenomena. Prof. Mukherjee envisions a day when a designer can identify a material with new properties and drop it on to an integrated circuit with little compromise, thus marrying cheap computing with all-encompassing interaction with the environment. Prior to joining the faculty of UCSB Materials, Prof. Mukherjee conducted postdoctoral research at the IBM TJ. Watson Research Center in Yorktown Heights, NY.

UC SANTA BARBARA MATERIALS

On the eve of its 30th anniversary, the Materials Department honors its rich tradition of excellence, spirit of collaboration, and promise of the future with a new logo.

Join the Department in welcoming the next chapter of scientific achievement as the home of Today's Leaders for Tomorrow's Materials.