



Materials Newsletter

Dear Friends and Colleagues,

We appreciate this opportunity to update you on the state of the Department. The last few years have been a complicated time for all, and we are happy to be moving forward on an exciting trajectory for the future.

The Department continues to grow with the addition of six outstanding assistant faculty members over the last five years. These faculty are taking the Department into new directions with materials for next-generation batteries, power electronics, quantum information science, additive manufacturing, and biopolymer interfaces. We are particularly proud of Prof. Raphaële Clément, Prof. John Harter, and Prof. Angela Pitenis who recently received NSF CAREER awards for their leading-edge research.

Our faculty continue to be recognized at the highest levels of achievement including the election of Prof. Carlos Levi to the National Academy of Engineering and Prof. Craig Hawker to the National Academy of Sciences. Along with these successes, we also share the sad news of the passing of Prof. Art Gossard, one of the founding faculty members of the Department, in 2022.

Meanwhile, our graduate students continue to excel. Nearly a dozen have NSF Graduate Fellowships and they continue to garner honors at conferences such as TMS, APS, and MRS. We are particularly happy to be able to recognize their achievements beyond research in service and mentoring through a generous gift from Dr. Mason Hu ('89) and his wife for the annual Bright Horizons Service Awards.

We hope that you enjoy this slice of the recent news from the Department. We would be happy to see you on campus if you have a chance to drop by!

Michael Chabiny
Professor and Chair, Materials Department

By the Numbers

- #1** Materials Department, National Research Council
- #2** Public Materials Graduate Program, U.S. News & World Report (2023)
- 134** Graduate Students (Fall 2022)
- 5:1** PhD Student-to-Faculty Ratio
- 31** MS and PhD Degrees Awarded (2021-'22)

Among our current faculty, research professors, and emerti:

- 3** Nobel Laureates
- 16** National Academy of Engineering (NAE) members
- 7** National Academy of Science (NAS) members
- 4** Highly Cited Researchers, Clarivate Analytics (2022)
- 10** American Physical Society (APS) Fellows



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Left: Steven DenBaars
Right: Craig Hawker



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Faculty Awards and Recognitions

Above, left to right: Carlos Levi, Chris Palmstrøm, Tresa Pollock, Rachel Segalman, and Chris van de Walle

A snapshot of major awards and recognitions received by faculty from UC Santa Barbara's Materials Department within the past year.

Steven DenBaars *Distinguished Professor, Materials and Electrical & Computer Engineering*

Steven DenBaars was among the 109 members from 24 countries elected to the 2023 Fellow Class of Optica, the Society Advancing Optics and Photonics Worldwide, formerly known as the Optical Society (OSA). An elected member of the National Academy of Engineering, DenBaars was recognized for his "leadership and pioneering contributions to gallium nitride-based materials and devices for solid-state lighting and displays."

Craig Hawker *Professor, Materials and Chemistry & Biochemistry*

Craig Hawker was one of 120 new members elected into The National Academy of Sciences (NAS) in 2022. His election came a little more than a year after he was also admitted into the National Academy of Engineering. Hawker, the Alan and Ruth Heeger Chair in Interdisciplinary Science, was cited by the NAS for "contributions to polymer chemistry through synthetic organic chemistry concepts and the advancement of molecular engineering principles."

Carlos Levi *Mehrabian Distinguished Professor, Materials and Mechanical Engineering*

Carlos Levi was elected to the National Academy of Engineering (NAE) in March 2023. He was cited by the NAE "for contributions to the understanding and development of high-temperature engineered surfaces and multilayers used in advanced gas turbine engines." In recent research, Levi identified and elucidated the mechanisms by which deposits of molten silicates (CMAS) from volcanic ash,

sand, and dusty environments around the world cause accelerated degradation of aircraft engine components. He has applied that knowledge to help guide the development of thermal and environmental barrier coatings that can resist CMAS-induced failures. Levi became the ninth NAE member among the active faculty in UCSB's Materials Department.

Chris Palmstrøm *Distinguished Professor, Materials and Electrical & Computer Engineering*

Chris Palmstrøm was elected a fellow to the prestigious American Association for the Advancement of Science (AAAS), one of the pinnacles of the profession. His indispensable expertise in using molecular beam epitaxy to control the growth and the interface structure and chemistry of dissimilar materials has led to the creation of many novel materials having new and useful properties.

Tresa Pollock *Alcoa Distinguished Professor of Materials, Interim Dean, UCSB's College of Engineering*

Tresa Pollock received the 2023 Acta Materialia Gold Medal, a prestigious honor bestowed in recognition of the significant and lasting impact of her materials research and leadership in the field. Pollock, an elected member of the National Academy of Engineering and Vannevar Bush Faculty Fellowship recipient, became the first woman in the 49-year history of the medal to receive the award issued by a non-profit organization that represents 36 professional societies.

Rachel Segalman *Professor and Chair, Chemical Engineering, E.N. Kramer Professor of Materials*

Rachel Segalman has received several major awards and recognitions over the past eighteen months. She received the Ernest Orlando Lawrence Award in Condensed Matter and Materials Science, the Department of Energy's highest scientific honor. Segalman was cited for "significant fundamental materials science and engineering contributions to self-assembly and structure-property relationships in functional polymer systems, with specific applications to photovoltaic, thermoelectric, and membrane technologies." She also received the American Institute of Chemical Engineers' (AIChE) Andreas Acrivos Award for Professional Progress in Chemical Engineering. Segalman was also elected a fellow of AIChE and was named a fellow of the Royal Society of Chemistry, the oldest chemical society in the world.

Chris van de Walle *Distinguished Professor, Materials*

Chris Van De Walle received a 2022 Vannevar Bush Faculty Fellowship from the U.S. Department of Defense (DoD). The five-year fellowship, considered the DoD's most prestigious single-investigator award, will allow Van de Walle to develop new computational approaches to enhance the efficiency of electronic and optoelectronic devices based on wide-bandgap semiconductors. Out of the nearly fifty VB fellowships awarded by the DoD over the years, four have gone to current UCSB materials faculty. Van de Walle, Palmstrøm, Susanne Stemmer, and Tresa Pollock.

Rising Stars

Within a nine-month span, three assistant professors in the UCSB Materials Department, **John Harter**, **Angela Pitenis**, and **Raphaële Clément**, received Early CAREER awards from the National Science Foundation (NSF). The award, considered the highest honor given by the foundation to junior faculty, supports early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department.



Raphaële Clément will use the award to support her work on the materials advances needed to develop the next generation of low-cost, sustainable, and energy-dense rechargeable batteries. She will study derivations of a new class of high energy density compounds comprising Earth-abundant elements like fluorine, sodium, magnesium, aluminum, manganese, and iron.



Angela Pitenis seeks to solve a problem encountered by millions who use biomedical devices, such as silicone implants and contact lenses. Soft implant surfaces may induce inflammation by unintentionally increasing friction when the outer surface of the devices slides against living cells and tissues. Pitenis is investigating the dynamics of fragile interfaces with a long-term goal of creating low-friction interfaces for soft biomedical devices.



John Harter will study cutting-edge quantum materials that could fast track the development of quantum technologies. He will conduct experimental research on odd-parity superconductivity, which results from pairs of electrons whose orbits reverse their direction when space is inverted. The spontaneous breaking of inversion symmetry by the electron pairs leads to unique properties and could be key to solving a major obstacle to building a functioning and scalable quantum computer.

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among public universities with the highest percentage of eligible junior faculty in engineering and the sciences who have received CAREER awards in the past five years.

New Faculty Profiles



Ananya Renuka Balakrishna

Ananya Renuka Balakrishna joined the Materials Department faculty as an assistant professor in November 2022. She investigates the delicate interplay between atomic-scale crystallographic changes and the continuum-scale microstructural evolution that shapes

physical properties of phase transformation materials. She develops and applies physics-based models (e.g. phase-field methods, molecular dynamics) to understand how microstructures form and evolve during phase transformations, and how these evolution pathways govern macroscopic properties of energy-related materials.

Currently, her group is investigating how the mechanical straining of intercalation electrodes can circumvent their structural degradation upon repeated cycling. While suppressing chemo-mechanical degradation has been a longstanding problem, her group's work initiates a new line of research by using mechanical stress states and crystallographic microstructures to regulate the energy landscape in intercalation materials and to thus improve their lifespans.

Previously, Renuka Balakrishna was an assistant professor of aerospace and mechanical engineering at USC. She earned her PhD in solid mechanics and materials engineering at the University of Oxford, and pursued postdoctoral research as a Lindemann Fellow at the Massachusetts Institute of Technology and the University of Minnesota.



Daniel Oropeza

Daniel Oropeza will join the Materials Department as an assistant professor in July 2023. Currently, he is a postdoctoral fellow at NASA's Jet Propulsion Laboratory. Oropeza earned his PhD in mechanical engineering from the Massachusetts Institute of Technology, a master's in aeronautics and astronautics from Stanford University, and his bachelor's degree from The University of Texas at Austin. Additionally, he has spent time in industry working as a research engineer for advanced materials and manufacturing technologies at Lockheed Martin.

Oropeza's research explores new materials and manufacturing technologies, while mapping correlations between process parameters, material microstructure, and component properties. His work will couple fundamentals from material science and mechanical engineering, spanning the study of material synthesis and characterization, machine and equipment design, and manufacturing process fundamentals, to develop next-generation alloys and ceramic materials. Initial research activities will aim to synthesize, process, and characterize novel high-temperature alloys, magnetic materials, and functional ceramics. These research efforts have application and impact in the areas of hypersonics, sustainable aviation, space exploration, healthcare, and energy generation.

Graduate Student Awards



Kira Wyckoff

PhD Student

Kira Wyckoff received an Excellence Research Graduate Fellowship from UCSB's Institute for Energy Efficiency (IEE). A fifth-year materials PhD student, Wyckoff is advised by materials professor Ram Seshadri. Focused on the next generation of lithium-ion battery electrode materials, Wyckoff works to overcome the deficiencies of rapid lithium insertion, which include particle cracking and diminished performance. Improvements to those issues are critical for more practical electric vehicles with more efficient and reliable batteries.



Saurav Roy

PhD Student

Saurav Roy, who is advised by materials assistant professor Sriram Krishnamoorthy, received an Excellence Research Graduate Fellowship from UCSB's Institute for Energy Efficiency (IEE). Roy works on the design, modeling, and fabrication of novel gallium oxide-based devices for high-voltage and high-current applications. The use of an ultra-wide bandgap semiconductor (UWBG) in power electronics could significantly reduce energy loss during power conversion and drastically reduce carbon dioxide emissions.



Lauren Poole

PhD Student

Lauren Poole, a materials PhD student co-advised by materials professors Frank Zok and Irene Beyerlein, was recognized with an Early Career Speaker Award for her presentation at the 2022 Biennial American Physical Society (ACS) meeting on Shock Compression of Condensed Matter. She presented her work on metal composites and her investigation into the interplay of microstructure, strain rate, and load state on their dynamic mechanical behavior.

In Memoriam: Professor Art Gossard

UC Santa Barbara, the UCSB College of Engineering, and the materials science and engineering world more broadly lost one of its giants with the passing of UCSB professor emeritus Arthur C. Gossard, who died on June 26, 2022, in Santa Barbara. He was survived by his wife, Marsha, his daughter, Sue, his son, Christopher, and several grandchildren.

Gossard was a pioneering scientist in materials that would enable the revolution in electronics and photonics. Working closely with UCSB professor and eventual Nobel Laureate Herb Kroemer, Gossard spearheaded the use of a then-novel technique — molecular beam epitaxy (MBE) — a method of “growing” a thin film of one material on top of another by depositing each layer, atom by atom, in an ordered fashion. Gossard, who developed his MBE expertise at Bell Labs, had the goal of discovering new physical phenomena and developing high-performance electrical and optical devices. That research would eventually enable dozens of indispensable technologies, including wireless communications equipment, fiber-optics, light-emitting diodes, solar cells, cell phones,



Arthur Gossard and President Barack Obama

communication satellites, laptop computers and data centers, optoelectronics, and solid-state lighting.

“Professor Art Gossard was a pioneer in GaAs (gallium arsenide)-based materials and quantum devices,” said UCSB materials professor and Nobel Laureate Shuji Nakamura. “He helped build UCSB into a world-leader in compound semiconductors.”

Born June 18, 1935 in Ottawa, Illinois, Gossard received his bachelor's degree in physics from Harvard University in 1956 and a PhD in physics from UC Berkeley in 1960. He worked at Bell Labs from 1960 to 1987, joining the UCSB faculty in 1987 as a professor with appointments

in both the Materials and the Electrical and Computer Engineering Departments. There, he pioneered the growth of epitaxial composites of metallic erbium arsenide and related rare-earth compound nanoparticles in semiconductor hosts. He developed improved thermoelectric materials for the direct creation of electrical power from waste heat and produced semiconductor devices that increased electron-hole tunneling for creation of multicolor solar cells. His work most recently produced high-performance quantum-dot lasers grown epitaxially on on-axis silicon substrates, an advancement that is enabling the replacement of copper with light beams as the interconnects on computer chips.

Over his career, Gossard wrote more than thirteen hundred research papers and received numerous awards including the 1983 Oliver Buckley Condensed Matter Physics prize and the 2001 James McGroddy New Materials prize from the American Physical Society. He was elected to the National Academy of Engineering in 1987 and to the National Academy of Sciences in 2001. He received the U.S. National Medal of Technology and Innovation in 2016.