UC SANTA BARBARA

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Luminaries

To the consumer, the emergence of state-of-the-art technology can look seamless and easy: Almost like clockwork, our devices get smarter, our displays brighter, our communications faster, our instruments more powerful and efficient. In other situations, new technology appears on the market fully formed; most people know little of the years of tireless work and research that lay the foundation for the innovations that benefit us on a regular basis.

Fortunately, such was not the case during Compound Semiconductor Week 2021, an international gathering of the finest minds behind compound semiconductors, a technology whose materials and techniques underlie many of our most advanced devices. Two UC Santa Barbara professors — Steven DenBaars and John Bowers — were recognized with two of the conference's top awards, the ISCS Quantum Devices Award (DenBaars) and the IPRM Award (Bowers).

"We are tremendously proud of Steven DenBaars and John Bowers for being recognized with these prestigious awards," said Rod Alferness, dean of the UC Santa Barbara College of Engineering. "Their relentless innovation and spirit of collaboration have resulted in pioneering technological breakthroughs that have positively impacted many aspects of daily life. Professor DenBaars stands at the forefront of the development of gallium nitride-based laser diodes and LEDs, while Professor Bowers' pioneering work in integrated photonics has brought the power of light to increase the capacity and energy efficiency of massive interconnection networks inside data centers. We congratulate both of these superb professors on their richly deserved honors."

A Leader in Solid State Lighting

“I am so honored by this award from ISCS, and especially want to thank my colleagues, professors Shuji Nakamura, James Speck and Umesh Mishra, John Bowers and the hardworking UCSB students for their contributions to these wonderful inventions,” said DenBaars, who was recognized by the International Symposium on Compound Semiconductors. DenBaars was cited “for the development and commercialization of non-polar and semi-polar quantum well laser diodes in laser lighting, automotive and general illumination.”

“These materials are having a huge worldwide impact in energy efficient lighting, communications and electronics,” he said.

The materials he is referring to are nitride semiconductors, known for their wide bandgap and their applications in ultraviolet to visible spectrum optoelectronics. Gallium nitride in particular is a foundation for one of the more recent breakthroughs in solid-state lighting: the bright blue LED, which opened the door to the white LED, and the subsequent proliferation of highly efficient solid state lighting all over the world.

DenBaars, who co-directs the university’s Solid State Lighting & Energy Electronics Center (SSLEEC), and his colleagues have gone beyond regular LEDs to develop solid state laser lighting, which is several times more efficient and powerful. The technology has been embraced by the automotive and general illumination industries for its brightness, efficiency and the versatility it provides to designers. The powerful, directed beams of solid state lasers show great potential in other applications as well, including sensors, displays and communications, and in the biomedical and industrial fields.

According to ISCS, DenBaars “has made seminal contributions to the science of nitride materials, and is recognized as an international authority on the growth and structure of nitride semiconductors by metal-organic chemical vapor deposition (MOCVD). He has performed pioneering work on polar, non-polar and semi-polar Gallium nitride (GaN) materials and devices.”

A professor of materials who holds the university’s Mitsubishi Chemical Chair, DenBaars joined the campus in 1991. In 1997 he and fellow GaN expert Umesh Mishra co-founded Nitres, Inc., one of the first GaN startups in the United States.

Nitres was acquired by Cree, Inc. in May 2000. With fellow professor Shuji Nakamura, UCSB alum James Raring and collaborator Paul Rudy, he co-founded SLD Laser in 2013 to pioneer blue lasers and laser lighting products. SLD Laser was acquired by Kyocera Corporation in 2021.

DenBaars is a member of the National Academy of Inventors and the National Academy of Engineers. He is also a fellow of the Institute of Electrical and Electronics Engineers.

Established in 2000 by Fujitsu Quantum Devices, Ltd., the ISCS Quantum Devices award is given to individuals for pioneering contributions to the fields of compound semiconductor devices and quantum nanostructure devices which have made a major scientific or technological impact in the past 20 years.

Integrating Photonics and Electronics

The ever growing tide of data we generate — due in large part to the proliferation of smart, internet-enabled devices and online apps and streaming services — means that the infrastructure needed to hold and move all that information has to double in speed and capacity roughly every two years to sustain high levels of performance.

Fortunately, researchers like John Bowers, a professor of electrical and computer engineering and of materials, have risen to the challenge of bringing light — unrivaled in speed, data capacity and energy efficiency — to our electronics and telecommunications systems. For “contributions to the development of III-V/Si photonics and heterogenous integration techniques with the pioneering demonstration of hybrid indium phosphide/Si laser,” Bowers was honored with the 2021 IPRM award by the International Conference on Indium Phosphide and Related Materials.

“We’ve been working on integration of photonics and electronics for the past 15 years, and it is very gratifying to be recognized by IPRM with this award,” said Bowers, who holds the Fred Kavli Chair in Nanotechnology and is director of the Institute of Energy Efficiency at UCSB. “I’m grateful for the hard work of so many students and postdocs to make heterogenous integration of lasers and photonic integrated circuits on silicon a reality, and to Intel, Juniper and others for commercializing this research. This work is the culmination of the research efforts of Alex Fang, Herb Kroemer, Art Gossard, Pierre Petroff, Evelyn Hu and many others,

and I’m very grateful to them for their ideas and collaboration ”

To take better advantage of light in our telecommunications, photonics — elements that produce, detect and modulate light — could be located on the same chip with electronic elements, allowing for a more efficient conversion between optic and electronic signals. Bowers’ work has been focused on how to merge the two technologies, in ways that are both cost-effective and manufacturing-friendly. In 2006 he demonstrated the first hybrid indium phosphide/silicon laser, bringing together the light production of indium phosphide and the waveguiding capabilities and cost-effective manufacture of silicon. IPRM called it a “groundbreaking technology” in the effort to “support the increase of transmission capacity and the reduction of cost and energy.” Bowers also developed indium arsenide quantum dot lasers grown directly on silicon, inexpensive devices that can emit a broad range of coherent wavelengths from single source.

Bowers is a member of the National Academy of Engineering and the National Academy of Inventors. He is a fellow of the Institute of Electrical and Electronics Engineers, the Optical Society of America and the American Physical Society.

The IPRM Award was initiated by the IPRM conference in 1993 and initially called the Michael Lunn Award. It was renamed the IPRM Award in 2007 and has since been sponsored by the IPRM international steering committee to recognize individuals who have made an outstanding contribution to the Indium phosphide community.

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.