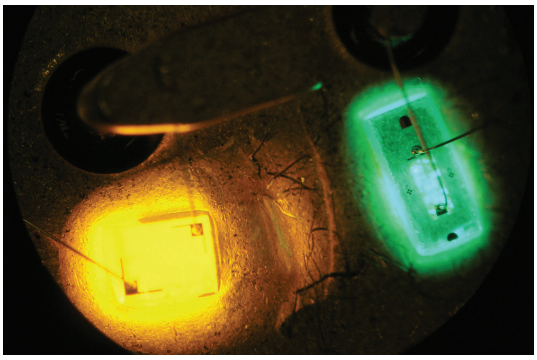
SUCCESS STORY: DR. SHUJI NAKAMURA WINS NOBEL PRIZE FOR LED BREAKTHROUGHS



Shuji Nakamura and his team continue to expand the world of applications for his GaN based, high-efficiency, blue and green LEDs

THE SITUATION

Lighting consumes 18 percent of the electricity generated in the United States and 35 percent of electricity in commercial buildings. Moreover, 20 percent of the average household energy bill covers power electronics and appliances, with a growing proportion consumed by high-tech devices.

Replacing conventional incandescent light bulbs with high-efficiency light-emitting diodes (LEDs) could save $155 billion and eliminate the need for 133 power plants. LEDs also have the benefit of a 50,000 hour lifetime and don't contain mercury, a serious downside of compact fluorescent lamps (CFLs).

Laser diodes, a related technology that produces a beam of light, could revolutionize technologies ranging from data storage to home entertainment and the medical field.

THE CHALLENGE

Tapping this potential requires high-quality red, green, and blue LEDs, which must be combined to make pure white light. To make matters more complex, the wavelength of today's laser diodes limits storage capacity. In addition, since a red laser's wavelength is much longer than a blue laser's, using the latter would quadruple storage density in comparison to existing DVD technology.

For more than three decades, Shuji Nakamura, co-director of the Solid State Lighting and Energy Center at UC Santa Barbara and an Institute faculty member, has worked to overcome these challenges. His groundbreaking research is expected to play a key role in changing society's relationship to energy consumption.

THE OBSTACLES

Nakamura's early research focused on developing red and infrared LEDs at a small Japanese technology company. Working on a very limited budget, Nakamura was forced to be unusually creative, even making his own furnaces to grow crystals because commercial models were far too expensive. Although Nakamura was successful in developing several cutting-edge LEDs early in his career, larger companies selling the same product were able to dominate the market.

In the late 1980s, Nakamura went to his superiors and convinced them to fund new research on the elusive blue LED. Nakamura was determined not to be beaten to the punch this time. Because so many other companies and universities were researching zinc selenide to develop the blue LED, he chose the less popular gallium nitride to make the blue LED.

After having difficulty growing his GaN epitaxial film by using the metal-organic chemical vapor deposition (MOCVD) method, Nakamura decided to modify his reactor. He added a second gas blower that reduced thermal convection and significantly improved the crystal quality of his GaN epitaxial film.

THE BIG IDEAS

Nakamura achieved a first-ever in 1993 when he created a blue LED. Although a number of other research efforts have since succeeded in creating blue and green LEDs, they produce light with low intensity and efficiency. Nakamura's key breakthrough was his discovery that by changing the crystal orientation of the GaN crystal, he could produce brilliant, high-efficiency blue and green LEDs.

These advances have finally made the pure white LEDs possible, as well as the ability to mix any color desired. Nakamura's LEDs now reach 150 lumens of light per watt consumed, compared to about 63 lumens per watt (lm/w) for a CFL and 15 lm/w for a traditional incandescent bulb. Efficiencies of 255 lm/w are theoretically possible.

As Time Magazine said in their article on Nakamura in 2007, "The world is a brighter place because Shuji Nakamura is not easily discouraged. In 1993 he astonished the scientific community with the first successful blue light-emitting diode, or LED. The blue LED was the last step in the creation of lighting's holy grail, the brilliant white LED--an ultra-efficient successor to Thomas Edison's incandescent lightbulb, circa 1879."

WHAT'S NEXT?

These breakthroughs have cleared the way for a number of futuristic technologies. Imagine watching a movie with friends using only your smart phone and its built-in miniature projector made from laser diodes.

Nakamura's advances could also bring artificial light to the 1/3 of the world's population without access to it. LEDs connected to solar batteries would require no wiring or long-distance electricity transmission to provide enough light for a child in the developing world to study after nightfall.

In 2007, Nakamura and Institute colleagues (Steven DenBaars, and James Speck) launched Soraa, a company based in Goleta, CA, to market this remarkable LED technology.