ACHIEVEMENTS OF THE 2008 KYOTO PRIZE LAUREATE IN ADVANCED TECHNOLOGY

Prize Field: Electronics

Dr. Isamu Akasaki

Pioneering Work on Gallium Nitride p-n Junctions and Related Contributions to the Development of Blue Light Emitting Devices

Dr. Isamu Akasaki conducted persistent research on gallium nitride (GaN) for many years toward the realization of blue light-emitting diodes (LEDs). His efforts culminated in the pioneering realization of GaN-based p-n junctions, which were once believed to be practically impossible. This achievement has stimulated research activities on blue LEDs worldwide, and served as the first firm step toward their commercialization. To this day, Dr. Akasaki has consistently played a leading role in a series of significant research endeavors. His contributions to the birth and progress of GaN-based blue LEDs certainly deserve the highest recognition the world over.

With their outstanding efficiency and long life, semiconductor LEDs can be used in a diverse range of applications. For this reason, R&D efforts in this area started early on, resulting in the development of LEDs capable of producing light in the visible spectrum, including red and green. With the addition of blue, it would be possible to produce all three primary colors of light using LEDs, raising expectations that the scope of applications could be expanded to include full-color displays and white-light illumination. It was also hoped that the development of blue laser diodes would lead to an even broader range of applications, as it would dramatically increase the recording density of optical discs.

These high expectations led to a flurry of attempts to develop blue LEDs around 1970, with many scientists around the world enthusiastically conducting research on the promising material of GaN. However, it was extremely difficult to improve the quality of GaN crystals and also control their properties. It was possible to form n-type GaN crystals, but p-type materials remained out of reach. A p-n junction, formed by combining p-type and n-type semiconductors, is essential to the development of LEDs. As a result, many researchers gave up on their attempts to develop GaN-based blue LEDs and withdrew from such attempts by the end of the 1970s.

Dr. Akasaki, however, did not. He resolutely continued his research and went on to find in 1985 that the crystalline quality of GaN can be remarkably enhanced by forming a buffer layer at low temperatures on a sapphire substrate before growing the GaN crystals. With the cooperation of Dr. Hiroshi Amano and other researchers, in 1989 Dr. Akasaki made a groundbreaking discovery. His work demonstrated that p-type GaN can be formed by doping magnesium (Mg) atoms into high-quality GaN crystals and irradiating them with electron beams. Using this method, he and his group were able to create the world's first GaN-based p-n junction blue LEDs.

These achievements literally shed new light upon the potential of GaN as a material for blue LEDs, and restimulated GaN researchers. They induced intense R&D activities to elucidate how magnesium atoms are activated to make p-type GaN and to establish the technological basis for the commercialization of blue LEDs. These efforts bore fruit when blue LEDs went on the market in 1993. Today, these devices are extensively used in displays and lighting. Blue laser diodes were commercialized in 1999, and played a pivotal role in the advent of very high-density optical recording systems. Throughout these developments, Dr. Akasaki has played leading roles in this field by his consistent and barrier-breaking research for the realization of blue light emitting devices.