

***Imperial Prize and Japan Academy Prize to:***

Isamu AKASAKI  
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 nologies, Meijo University  
 University Professor and Emeritus Professor,  
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for “Creation of GaN-Based Semiconductors  
 of Excellent Quality and Invention of p-n  
 Junction Blue-Light-Emitting Devices”

***Outline of the work:***

Scientific achievements in the nitride semiconductor field made by Prof. Isamu Akasaki and his group have been applied to the production of GaN-based light-emitting diodes (LEDs), which are increasingly being used in general lighting applications worldwide. His leading contributions include the invention of low-temperature-deposited buffer layer technology, which enabled the growth of a high-quality GaN single crystal on a highly lattice-mismatched sapphire substrate in 1986; the discovery of p-type GaN by Mg doping and post-growth treatment in 1989; and the achievement of conductivity control in n-type GaN in 1990. He demonstrated the first p-n junction blue LEDs in 1989; the first UV stimulated emission from GaN at room temperature with one order of magnitude lower optical power in 1990, which is indispensable to the development of laser diodes and other outstanding results.

Most researchers abandoned the nitride semiconductor field in the 1970s, because they could neither grow high-quality GaN single crystals nor control its electrical conductivity (especially p-type conduction), both of which are indispensable for high-performance light-emitting devices. GaN single crystal films were considered too difficult to grow, because the high atomic bonding energy and lack of lattice-matched substrate material were considered insurmountable obstacles that prevented the progress of nitrides. Despite these difficulties, Prof. Akasaki has continued to address the challenges in this field since 1973 based on his deep insight and conviction for the immense potential of GaN. After numerous attempts at GaN film growth, in 1979, he decided to adopt an organometallic vapor phase epitaxial (OMVPE) growth method (also called MOVPE or MOCVD), which, at the time, was considered an unconventional approach. To overcome the large lattice mismatch between the GaN epilayer and the sapphire substrate, he introduced a thin buffer layer deposited at a low temperature of approximately 500 °C before the growth of GaN at approximately 1,000 °C, and he succeeded in growing an extremely high-quality GaN epilayer in 1986. This was his first breakthrough and one of his greatest contributions to nitride semiconductors. This result led to his next breakthroughs: the discovery of p-type conduction in GaN and the conductivity control of n-type GaN. Of particular note, before that time, researchers commonly believed that the realization of p-type GaN was theoretically impossible. However, Prof. Akasaki patiently attempted to realize p-type GaN and successfully overturned this belief. The discovery of p-type GaN had a major impact worldwide, and since this turning point, a large number of semiconductor researchers at research institutes around the world have entered the nitride field.

Prof. Akasaki has since continued his work as a leader in nitride semiconductor research and has made

further contributions to material science, including the verification of quantum size effects, clarification of the mechanism of piezoelectric polarization, and further improvement in the crystal quality of nitride alloys. These scientific and technological achievements have become worldwide standards in the production of nitride-based devices.

In 1993, a Japanese company announced the first production of nitride-based blue LEDs, which caused great excitement worldwide. This success was built on Prof. Akasaki's work, along with some modifications, indicating the fundamental importance of his leading contributions. As a result of his recognition as a pioneer in developing the GaN-based blue LED, he was invited to more than 140 international conferences as a keynote speaker or invited speaker within 10 years after the announcement of high-brightness LEDs. Through the commercialization of blue LEDs, white LEDs, blue laser diodes, and high-frequency transistors, his research achievements have been further acknowledged.

He has published more than 700 journal/international conference papers, has been granted more than 200 patents, and has been awarded a number of prestigious prizes and honors.

### Selected publications

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