Recent News

Be brave, walk on your own path

2014 Nobel laureate Shuji Nakamura on the development of Blue LED and the spirit of scientific research

Professor Shuji Nakamura, the 2014 Nobel laureate in Physics, was invited as the 11th Academia Sinica Lecturer. On February 8, 2017, he delivered a lecture entitled "The Invention of High Efficient Blue LEDs and Future Solid State Lighting" at the International Conference Hall (3F) of the Building for Humanities and Social Sciences, Academia Sinica. During the lecture, Professor Nakamura shared the invention and impact of blue LEDs and the development and possible applications of laser lighting technology. About 400 people attended the event, crowding the lecture hall and heating the air on a cold winter day.

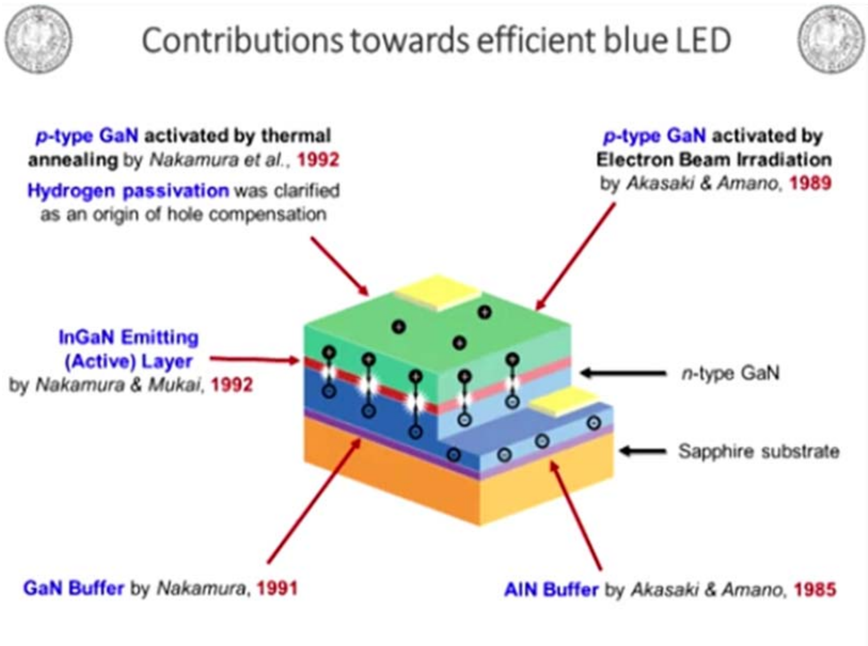
Academia Sinica Lecturer is the highest honor of Academia Sinica. The honor is bestowed on Nobel Laureates and scholars of similar caliber across the world. Before the lecture, President Liao, the host of the Lecture, awarded the badge of Honorary Academician to Professor Nakamura. President Liao said the invention of blue LEDs was a major breakthrough in human history. He honored professor Nakamura as a dedicated scientist. "He's solved a very important problem in science…. If we look back at his past history we can easily notice that he could really care about publications, and count impact factors, but he's been focusing on solving real problems, and he did what he wanted to do. This is true hero of science…. He provides a very good role model for all of us," President Liao commented.

Professor Nakamura started his research into blue LEDs in 1989 using group-III nitride materials. In 1990, he developed a novel chemical deposition method for growing gallium nitride (GaN) semiconducting crystalline layers named two-flow metalorganic chemical vapor deposition (MOCVD). Using this system, he could grow GaN-based materials with the highest crystal quality. In his private opinion, the invention of two-flow MOCVD was the biggest breakthrough in his life and his GaN-based research, he said.

Using the two-flow MOCVD, he successfully realized p-type GaN. He used thermal annealing of magnesium-doped GaN in a nitrogen gas flow and obtained a more uniform and thicker p-type layer which was made possible with low-energy electron-beam irradiation (LEEBI). In 1992, he grew the first indium gallium nitride (InGaN) single crystal layers which functioned as the light-emitting layer between the p-type and n-type GaN layers; successfully forming a double heterostructure (DH); and greatly improved the luminous efficiency over that of homojunctions. Using the improved InGaN film, Professor Nakamura fabricated surprisingly bright DH blue LEDs for the first time in 1993. The invention of InGaN was directly adopted for the development of violet laser diodes, which were later applied to the blue-ray DVDs. In 1999, the violet laser diodes began to appear in the market for application in blue-ray DVDs.

Before giving his lecture, Professor Nakamura was invited to give some advice to young scientists. “The most important thing (for a scientist) is to study a lot, do a lot of research, and make a lot of experiences,” he said. With lots of experiences, a scientist also has to gamble with his research. He said, “If you don’t do the gambling, you don’t win the bet. This means if people say this is common sense, you have to doubt this common sense. You have to have the bravery to go to a totally different way. What I said about gambling means that if one thousand people go in this direction you have to go to a different direction ALONE. The possibility of being successful could be very small, (the win rate of) this gambling may be only 0.00%; but if you can bet, even with only 1% possibility to win, it’s still big bliss. If you go in the same direction as one thousand people to do the same things, there’s no bliss even if you finally succeed.”

Professor Nakamura took his own experience as an example. When he began the research on blue LED in 1989, zinc selenide (ZnSe) was grown on GaAs with a dislocation density less than 10^3 cm^{-2}. It was very popular among scientists given the high crystal quality and the prevailing notion that a dislocation density below 10^3 cm^{-2} is needed to achieve optically functional LEDs with high efficiency and a long lifetime. Therefore, most researchers worked on ZnSe at that time. On the other hand, GaN was grown on sapphire, yielding dislocation densities on the order of 10^9 cm^{-2}. Unsurprisingly, only very few researchers were working in this field. When he participated in the conference held by Japan Society of Applied Physics (JSAP) in 1992, there were approximately 500 individuals attending the ZnSe sessions, whereas for GaN, there were only 5, including the Chair Professor Isamu Akasaki, speaker Hiroshi Amano, and himself, as a member of the audience. The three of them were together awarded the Nobel Prize in Physics in 2014.



Caption: The contrition of the 2014 Nobel laureate in Physics, Shuji Nakamura, Isamu Akasaki and Hiroshi Amano to blue LED.

Another important impact brought by blue LEDs was energy saving and CO2 reduction. According to an estimation by the US Department of Energy, due to the widespread use of white LEDs, in the US alone, the improvement of energy saving will be 40% in 2030. Furthermore, this reduction in energy usage will eliminate the need for at least 30 power plants at the gigawatt-level by 2030 and avoid generating 185 million tons of CO2. In view of global energy saving, due to the use of white LEDs, an amount of energy equivalent to that produced by 19 nuclear power plants in the US, 17 in China, 7 in Japan, and 9 in India will be saved by 2020.

At the media conference after the lecture, Professor Nakamura was asked about the possible impact of Li-Fi, the next-generation technology for communication systems based on laser lighting, might bring to society. He emphasized the efficiency brought by high-speed transmission of Li-Fi technology. The transmission rate of LED Li-Fi will be 10 times that of the Wi-Fi currently in use, and laser Li-Fi will be even 100 to 1,000 times faster than Wi-Fi, he explained. It will be able to transmit Gigabytes of data within one second. In highly populated areas, Li-Fi will have a more obvious impact and be more convenient than in the less populated regions, he said. The characteristics are also ideal for applications in many other fields of scientific research, as well as being more safe and economic.

Professor Nakamura also mentioned LED technology has developed beyond his imagination. He took the research conducted by Dr. Chau-Hwang Lee, a Research Fellow at the Research Center of Applied Sciences, Academia Sinica, as an example. Dr. Lee developed a technology to block cancer cells from normal ones using blue LEDs. Professor Nakamura said that this is very impressive. Dr. Lee also added that he found that the blue LED technology can also been applied to many different scientific research fields, such as cell biology or molecular biology. When a reporter asked Professor Nakamura about the possibilities of laser lighting for becoming popular in our daily life within 10 years, he replied that the laser lighting is still at its initial stage, we may have to wait for a while to see laser lighting in common use. Up to now, it has been used for the headlights on the cars.

At the end of the conference, Professor Nakamura suggested that young people find what they are really interested in and dive into it. To him, doing research is like taking one quiz after another. He has been enjoying doing so, he says, and it has also pushed him to go further and further. He believes that everyone has the potential to receive a Noble Prize if they do what they are really fond of doing.