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The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2014 to **Isamu Akasaki**, **Hiroshi Amano** and **Shuji Nakamura** "for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources".

The Nobel Prize 2014 **in Physics**

New light on the world

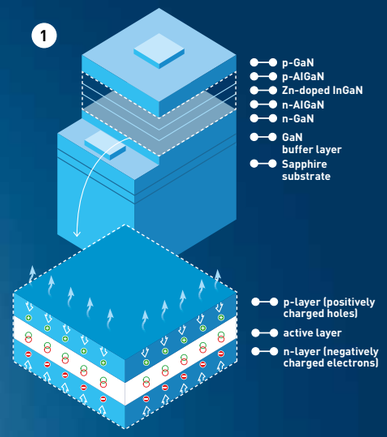
Isamu Akasaki, Hiroshi Amano and Shuji Nakamura have been recognised for their invention of a new energy-efficient and bright light source – the blue light-emitting diode (LED). In the spirit of Alfred Nobel the Prize rewards an invention of greatest benefit to mankind: using blue LEDs, white light can be created in a new way.

When Isamu Akasaki, Hiroshi Amano and Shuji Nakamura produced bright blue light beams from their semiconductors in the early 1990s, they triggered a fundamental transformation in lighting technology. Red and green diodes had been around for a long time, but white LED lamps could not be created without blue light. Despite considerable efforts, both in the scientific community and in industry, the blue LED had remained a challenge for three decades.

They succeeded where everyone else had failed. Akasaki worked with Amano at Nagoya University, while Nakamura was employed by Nichia Chemicals, a small company in Tokushima. Their inventions were revolutionary. Incandescent light bulbs lit the 20th century; the 21st century will be lit by LED lamps.

White LED lamps, with a blue light-emitting diode at their heart, emit a bright white light, are long-lasting and energy-efficient. They are everywhere – in mobile phones, TV and computer screens, in inside and outside lighting.

About one fourth of global electricity consumption is used for lighting. Because LED lamps require less power than older light sources, they can help to save the Earth's resources. The invention of an efficient blue LED is just twenty years old, but has already contributed to the creation of white light in an entirely new manner that benefits us all.



1. The LED

The heart of a light-emitting diode, no larger than a grain of sand, consists of several layers of semiconducting materials: an n-layer with a surplus of negative electrons, and a p-layer with an insufficient amount of electrons. This is also referred to as a layer that has a surplus of positive holes. An active layer is created when an electric voltage is applied to the semiconductor; the electrons and the holes recombine and thus emit light. The light's wavelength depends entirely on the semiconducting material, and gallium-nitride is used to produce blue light.

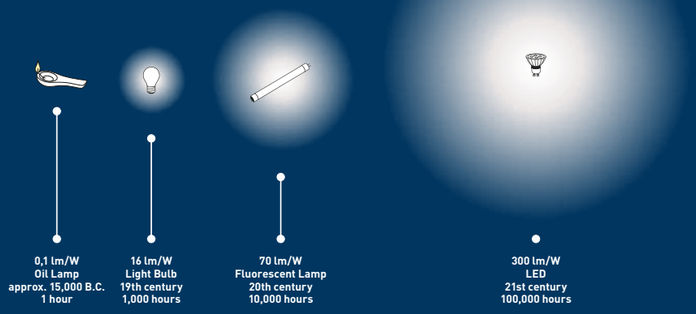
The two greatest challenges, at which no one had previously succeeded, were building gallium-nitride crystals of high quality and creating an effective p-layer in this material. The Laureates then increased the lamp's efficiency by using several thin layers of gallium-nitride (GaN), adding indium (In) and aluminium (Al). An example of such a LED is shown above.

White light

Red, green and blue combine to produce white light. White LED lamps can be created in two different ways. One is that blue light excites a substance in the lamp which emits green and red light, thus producing white light. The second way is to construct a lamp out of three LEDs – red, green and blue – and let the eye do the work of combining the three colours into white.

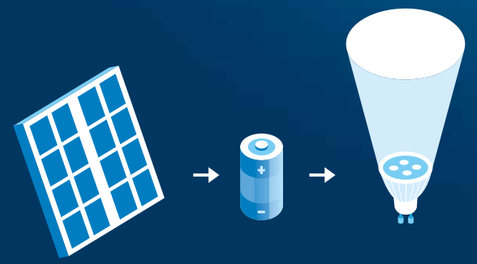
The light revolution

White LEDs have given us more sustainable and efficient alternatives to the older light sources. They emit a higher luminous flux (measured in lumen) per unit of electrical input power (measured in watt). Material use is reduced as the lamp has longer lifetime, and LED lamps do not contain mercury.



Reason for optimism

An LED lamp and simple solar cells can increase the quality of life for the more than 1.5 billion people who lack access to electricity grids: the LED's low electricity consumption means it can be run using cheap local solar power. Moreover, polluted water can be sterilised using ultraviolet LEDs, a further development of the blue LED.



Isamu Akasaki
Japanese citizen. Born 1929 in Chiran, Japan. Professor at Meijo University, Nagoya, and Distinguished Professor at Nagoya University, Japan.

Hiroshi Amano
Japanese citizen. Born 1960 in Hamamatsu, Japan. Professor at Nagoya University, Japan.

Shuji Nakamura
American citizen. Born 1954 in Ikata, Japan. Professor at University of California, Santa Barbara, CA, USA.

FURTHER READING! More information on the Nobel Prize in Physics 2014: *http://kva.se/nobelphysics2014* and *http://nobelprize.org* **BOOK:** ● **Khanna, V.K.** (2014) *Fundamentals of Solid State Lighting: LEDs, OLEDs, and Their Application in Illumination and Displays*, CRC Press **ARTICLES:** ● **Zheludev, N.** (2007) The life and times of the LED – a 100-year history, *Nature photonics*, vol. 1, April ● **Schubert, E. F.** and **Kyu Kim, J.** (2005) Solid-State Light Sources Getting Smart, *Science*, 308, 1274 ● **Savage, N.** (2000) LEDs light the future, *Technology Review*, vol. 103, no 5, p. 38–44, September–October ● **More references can be found in the Scientific Background:** *http://kva.se/nobelphysics2014*

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