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 Gakuto, Japan. Their innovations were revolutionary.

Incandescent light bulbs lit the 20th century; the 21st century will be lit by LED lamps.

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

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 phosphor in the lamp which emits red and green 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 combing the three colours into white.

The light revolution

While LEDs have given us more sustainable and efficient alternatives to the older light sources, they are two-dimensional 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 semiconductors; the electrons and the holes recombine and thus emit light. The light’s wavelength depends exactly on the materials they are made of, and gallium-nitride is used to produce blue light.

The heart of a light-emitting diode, no larger than a grain of sand, consists of several layers of semiconducting materials, one layer with a surplus of negative electrons, and 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 semiconductors; the electrons and the holes recombine and thus emit light. The light’s wavelength depends exactly on the materials they are made of, and gallium-nitride is used to produce blue light.

The Laureates then increased the lamp’s efficiency by using several thin layers of gallium-nitride, adding gadolinium fluoride and aluminium nitride. An example of such a LED is shown above.

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 solar power. Moreover, polluted water can be sterilised using ultraviolet LEDs, a further development of the blue LED.

White LEDs have given us more sustainable and efficient alternatives to the older light sources. They exploit the luminescence of semiconductors in an air-permeable p-n junction. Light is produced when the electrons and the holes recombine and thus emit light. The light’s wavelength depends exactly on the materials they are made of, and gallium-nitride is used to produce blue light.

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 1940 in Moriyama, Japan. Professor at Nagoya University, Japan.

Shuji Nakamura


Further reading


1. The LED

2. White light sources

3. White LEDs

4. Reason for optimism

5. The light revolution

6. The LED

7. White light

8. LED lamps