Professor M. Kawasaki -- Realization of Super Luminosity Zinc Oxide Ultraviolet Light-emitting Diodes using General-purpose Manufacture Method –

- Expectation for Application as Economical Solid-state Illumination Source -

A research group led by Professor Masashi Kawasaki at WPI Advanced Institute for Materials Research, Tohoku University, ROHM Co., Ltd., Institute for Materials Research and Institute for Multidisciplinary Research for Advanced materials, Tohoku University has successfully produced zinc oxide (ZnO) ultraviolet light-emitting diodes and increased its luminosity by using molecular beam epitaxy (MBE) method, a general-purpose technology of semiconductor device manufacture. The newly developed device uses conductive ZnO substrates, which will lead to application of economical short-wavelength light-emitting device.

Light-emitting diode (LED) consists of p- and n-type semiconductor layers that are conductively controlled. Applying electrical current with the device helps convert into light with the same energy as semiconductor forbidden bandwidth. Recently, gallium nitride (GaN) blue LED and white LED using phosphor have been used for backlight of crystal liquid displays and illumination source, and these LEDs can significantly save power consumption compared with cathode-ray and florescent tubes. Forbidden bandwidth of ZnO has reached to the ultraviolet range to widen options for excited phosphor, which leads to production of well-balanced white light source. Energy saving is expected to be further promoted, and application development of general-purpose technology for quantity production of super luminosity ultraviolet LED is necessary. Super luminosity ultraviolet LED has not been realized because, generally, ZnO materials have been difficult to be controlled to be p-type, and the technology for magnesium-doped ZnO (MgZnO) has not been established.

The research group has successfully realized p-type MgZnO on commercial ZnO substrates using MBE method, and significantly increased luminosity of ultraviolet LED. The emission wavelength of the newly developed p-type MgZnO reached to the ultraviolet range, and its luminosity is more than 10,000 times stronger than p-type ZnO developed by Tohoku University in 2004. The group also found that ammonia gas is helpful to supply nitrogen for p-type conductivity control, in addition to the use of appropriate method of semiconductor device production. The achievement includes that green phosphor is excited by pure ultraviolet ray from LED device, and shows possible light source of white LED.

The research has been conducted as part of Core Research for Evolutional Science and Technology (CEST) by Japan Science and Technology Agency (JST), and the result has been published online in Applied Physics Letters soon. The paper's title is "Nitrogen doped MgxZn1-xO / ZnO single heterostructure ultraviolet light-emitting diodes on ZnO substrates."

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