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210-nm AlN light-emitting diode

- Increased emission by non-polar planes -

NTT

Motivation

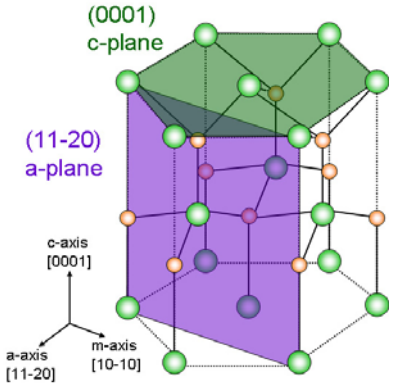
Aluminum nitride (AlN) is a direct-bandgap semiconductor with a bandgap energy of 6 eV, the largest among semiconductors. Therefore, it has been theoretically predicted that an AlN light-emitting device would emit light with the shortest wavelength for semiconductors. We fabricated an AlN p-n homojunction light-emitting diode (LED) and observed deep-ultraviolet (deep-UV) light with a 210-nm wavelength. This is the shortest wavelength ever emitted from any semiconductor. For practical use, we are developing high-efficiency AlN deep-UV LEDs.

Originality

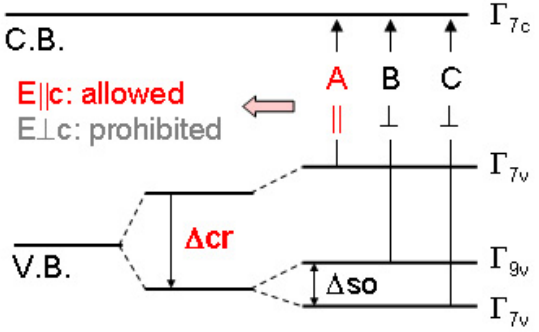
AlN is conventionally grown with c-axis surface orientation because c-plane growth leads to lower defect density. However, because AlN has a negative crystal-field splitting energy Δcr, the emission strongly polarizes for E//c. The emission intensity from the a-plane or m-plane is therefore estimated to be 25 times stronger than that from the conventional c-plane. Here, we fabricated an a-plane AlN LED and successfully demonstrated 210-nm deep-UV light emission.

Impact

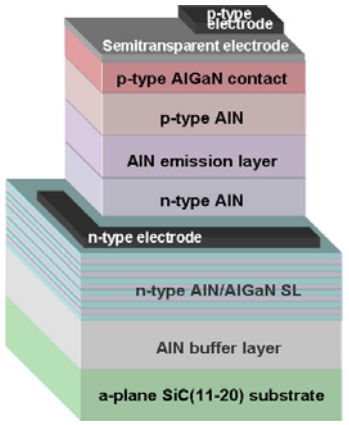
High-efficiency AlN LEDs will replace large and toxic gas deep-UV light sources, such as mercury lamps or excimer lasers, with compact and harmless semiconductor light sources. Because light with a shorter wavelength has a higher energy, AlN LEDs can be applied as light sources for decomposing very stable, toxic chemical substances, such as dioxin and polychlorinated biphenyls (PCBs), which cause serious environmental problems all over the world.



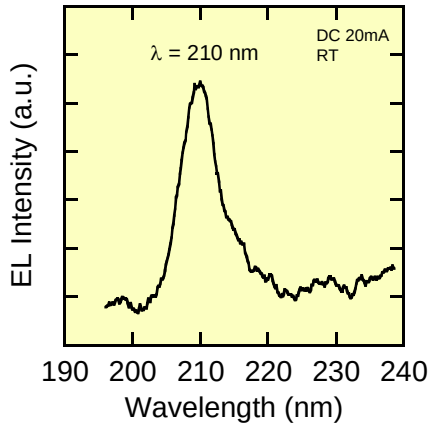
AlN crystal structure



Selection rule of optical transition for AlN



a-plane AlN LED structure



Emission spectrum of a-plane AlN LED

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