Vertical AlGaN Deep-UV LEDs Grown on Si Using Nanowire-Assisted AlN Template by Molecular Beam Epitaxy

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Aluminum gallium nitride (AlGaN) deep ultraviolet (UV) light emitting diodes (LEDs) are the ideal candidates to replace the conventional bulky, poisonous mercury lamps for deep UV light emitting in various applications. In addition, given the advantages of uniform current injection, reduced joule heating, and easy chip packaging process, fabricating vertically injected AlGaN deep UV LEDs have been an interest of research. Hitherto, existing AlGaN deep UV LEDs rely mainly on lateral injection, hindered by the insulating substrates and the difficulty of substrate removal. In this context, silicon (Si) is a promising substrate choice, given its excellent conductivity and easy removal by wet etching. Nonetheless, owing to the large lattice and thermal mismatches between AlGaN and Si, thick AlN buffer layers and costly substrate patterning processes are required in order to realize high quality AlGaN thin films on Si.

In this work, we present a new path to realize vertical AlGaN deep UV LEDs on Si by plasma-assisted molecular beam epitaxy, which exploits a nanowire-assisted AlN buffer layer [1]. By using such a technique AlGaN epilayers over a wide Al content range have been obtained. Moreover, such as-grown AlGaN epilayers can possess a surface roughness as low as 0.4 nm (rms value). Further studies suggest that such AlGaN epilayers are metal-polar. As initial device demonstration, AlGaN double-heterojunctions (DH), schematically shown in Figure 1, are used. Such devices are able to emit light from 298 nm to down to 247 nm (Figure 2). Moreover, I-V characteristics as a function of device size indicate uniform current injection, due to the use of vertical injection scheme. Current progress on optimizing the growth of AlGaN epilayers as well as the device performance will be presented as well.

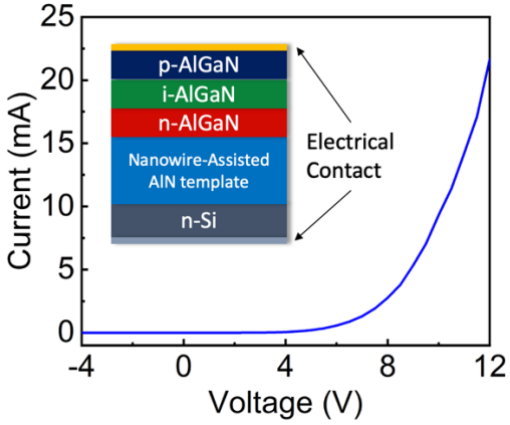

Figure 1. I-V characteristics of an AlGaN deep UV LED with inset showing the schematic structure (Device size: 1×1mm^2).

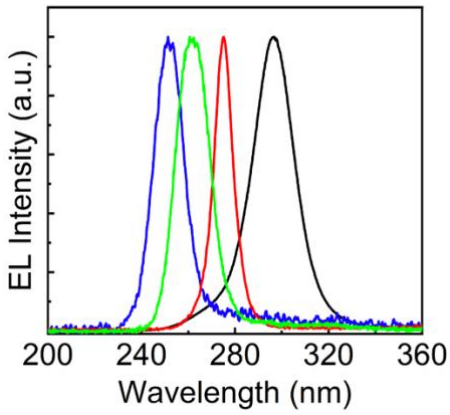

Figure 2. Electroluminescence (EL) Spectra of AlGaN DH LEDs with emissions at various wavelengths.

[1] X. Yin, Q. Zhang, and S. Zhao, *Cryst. Growth Des.*, **21**, 3645(2021).

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