High efficiency deep ultraviolet light emitting diodes (UV-LEDs) based on AlGaN with emission wavelengths of between 200 – 350 nm have attracted considerable attention due to their wide range of applications in air, water purification, disinfection, chemical sensors, bio-medical, etc\(^1\). However, AlGaN growth on AlN/Si substrates is challenging to achieve and therefore there are only a few reports of AlGaN-based deep UV-LEDs. Because, the large different lattice mismatch between AlN and Si substrate (23.4\%) leads to many challenges. In addition, the presence of an oxide on the surface of Si substrate also leads to low coherence between AlN template and the Si substrate. Especially, a low growth rate is the main obstruction factor to grow AlN template on Si and other substrates. Thus, the particular conventional growth of thick AlN template on Si substrate is a challenge for researchers.

In this study, we report the fabrication of micro-circle patterned-Si substrates (mPSiS) for further direct growth of thick AlN template on mPSiS by using the NH\(_3\) pulsed-flow multilayer AlN growth and epitaxial lateral overgrowth (ELO) techniques. Thereafter, an AlGaN multi-quantum wells (MQWs) based deep ultraviolet light emitting diodes (DUV-LEDs) was pre-grown on that template. The experimental results show that a 8-μm-thick AlN template was grown at a very high growth rate on the substrates had the full widths at half maximum of 0.23° and 0.37° for the (002) and (102) reflection planes in X-ray diffraction rocking curves. Transmission electron microscopy confirmed that the dislocation density was very low (1.5×10\(^8\) cm\(^{-2}\) (screw), 3.7×10\(^8\) cm\(^{-2}\) (edge)). Meanwhile, AlGaN multi-quantum wells grown on that coalescence AlN template shown a sharp photoluminescence (PL) peak at 270 nm. It confirmed that the AlN template which was grown on mPSiS can be used for deep UV-LED applications.

![Figure 1. SEM image of AlN template grown on mPSiS and its surface morphology.](image1)

![Figure 2. PL spectrum of AlGaN MQWs grown at different temperatures.](image2)

### References