Low Frequency Noise of GaN-Based Deep Ultraviolet Light Emitting Diodes

by

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ABSTRACT

This study covers the investigation of deep UV GaN-based light emitting diodes using low frequency noise characterization. Using this technique, device improvements were analyzed as feedback to developers and practical parameters were created for system use.

AlGaN LEDs emit wavelengths into the deep UV spectral region ($\lambda < 290$ nm). These devices are an integral component for applications including biological hazard detection systems, biological experimentation, food and water sterilization, non-line-of-sight short range communication, counterfeit identification, photolithography, and general white lighting. The current technological trend demonstrates a decrease in material quality and device performance with decreasing wavelength. However, progress has allowed for its commercialization in a relatively short period of time. Characterization of material and device improvements provides feedback for changes in development. Secondly, methods to determine the reliability and stability of these devices are essential to the applications for which they are used. One such method is through optical and current low frequency noise (LFN) measurements in which both system related parameters such as a signal-to-noise ratio for light sources and insight into the fundamental physics within the devices can be determined. The quality of the device can be compared before costly integration into systems that require low noise, high reliability, and optical stability. It not only quantifies performance limiting noise levels, but it is known to be a sensitive, nondestructive measure of material quality and reliability.

The research highlighted in this thesis demonstrates a new measurement technique in analyzing the light intensity fluctuations through low frequency optical noise. From this work, a proposed figure-of-merit is presented. Low frequency current noise was performed as a well known indicator of material quality. Each technique compares LEDs grown by SET Inc. LEDs of varying wavelengths along the UV spectrum, with different growth methods and device structures. The cross-correlation between optical and current noise was analyzed to further understand the physical mechanism of low frequency noise in LEDs. Finally, low frequency current noise analysis for the packaging process and electrical degradation were determined.