Small-signal analysis as a useful tool to investigate the nature of III-nitride semiconductor light-emitting devices

Dong-Pyo Han[1]
[1]*Display & Semiconductor Engineering, School of Electrical Engineering, Pukyong National University (PKNU), Busan 48513, Republic of Korea*

Researchers around the world are putting tremendous effort into improving the performance of III-nitride semiconductor light-emitting devices (LEDs) since they suffer size- and wavelength-dependent efficiency degradations. To overcome it with a scientific approach, an accurate analysis of LEDs' characteristics is very imperative. For this reason, many analysis/characterization methods have been suggested and now are being attempted. Of which, the analysis of small-signal response is very useful since it allows for providing physical properties of semiconductors.

Figure 1 shows the experimental results of resistance and reactance of impedance (R and X) as a function of reverse bias. From this basic small-signal response curves of LEDs, various semiconductor's characteristics such as depletion width, doping profile, carrier lifetime, and deep-level defect, can be obtained [1], [2]. The information obtained via small-signal analysis is very useful for feedback to improve LEDs' performance. In this presentation, the detailed procedures and methods for obtaining each characteristic from basic small-signal response curve will be presented. Futhermore, this study presented the accurate analysis of small-signal response for GaInN/GaN-based LEDs by establishing the analytic model, which was carefully designed considering the structure.

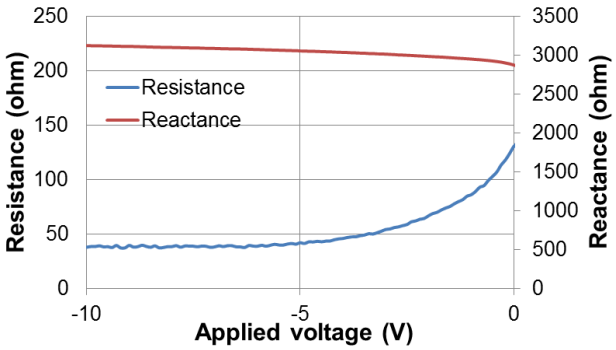

Fig. 1. R and X as a function of reverse bias

References:

[1] S. M. Sze and K. K. Ng, *Physics of Semiconductor Device*, 3rd ed., New Jersey, NJ, USA: Wiley 2007, Chapters 2–4.

[2] D. A. Neamen, *Semiconductor Physics and Device*, 4th ed., New York, NY, USA: McGraw-Hill 2012, Chapters 8–9.