Tips & Trends: Solving LED Droop

cmathas - March 04, 2014

The U.S. Naval Research Lab's scientists believe they can increase green-blue-ultraviolet LED efficiency based on GaInN/GaN, AlGaN/GaN, and AlInN/GaN quantum wells. According to the research, achieving a high rate of epitaxial perfection in quantum-well growth is key to achieving superior power, efficiency and performance. They anticipate the result could be used in low threshold lasers and LEDs and advances in solid-state lighting, according to a research paper published in Applied Physics Letters.

To date, using quantum wells used in high-power lighting apps suffer a significant loss of efficiency even at low electric currents. As current increases, efficiency suffers (droops) more. The problem is seen in the visible, blue, and UV regions.

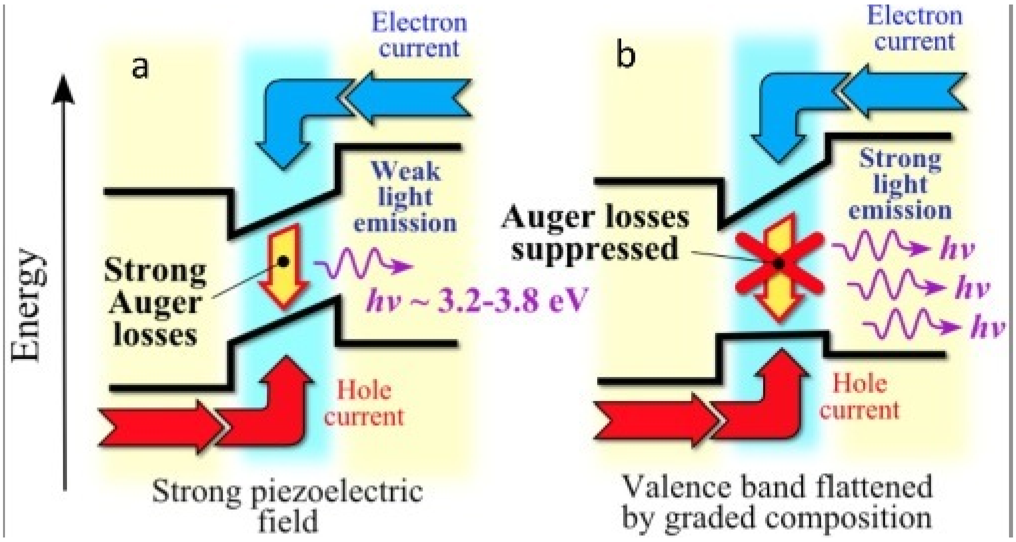

Figure 1. A schematic displaying the process, conventional on the left and droop suppressed on the right. *(Photo: U.S. Naval Research Laboratory)*

The scientists collaborated with Israel's Technion and Russia's Ioffe Physical-Technical Institute scientists to crease computational models that indicate the droop effect in efficiency is due to non-radiative Auger recombination of the injected carriers, showing that: "…the rate of the Auger recombination is proportional to the cube of the carrier concentration. As a result, the non-radiative Auger decay rate grows rapidly with current density, quenching the generation of light."

The Naval Research Lab innovated a process and patented it, whereby creating quantum wells with a soft confinement potential prevents carriers from acquiring the momentum necessary for non-radiative Auger processes, suppressing the decay rate. With their process the effect can be significantly or completely suppressed.

Potential reasons for droop have been offered for years. For example, Philips Lumileds claimed that Auger recombination was the cause for droop, Rensselaer Polytechnic Institute blamed carrier leakage, the National Taiwan University's team led by Yun-Li Charles Li offered that thin quantum wells were to blame, and Linkoping University's team cited defects as the culprit.

The Lab's patenting of the new process seems to indicate their level of certainty. It will be interesting to watch developments from here.