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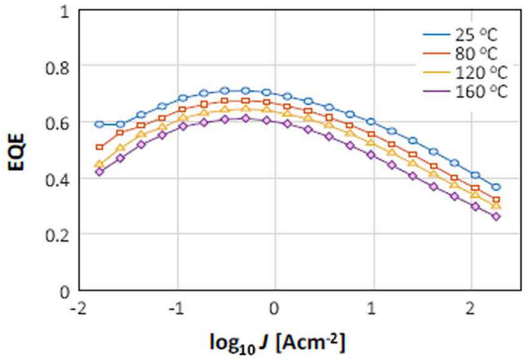
New research sought to understand the mechanism of thermal droop, a process that decreases LED efficiency at increased temperatures.



Indium gallium nitride (InGaN) LEDs are the basis of modern lighting, found in most screens and energy-efficient lightbulbs. But these ubiquitous devices are subject to thermal droop, a decrease in efficiency with increasing temperature. In a new paper, David et al. examined the origins of thermal droop in high quality InGaN LEDs.

The predominant processes that drive room-temperature efficiency – the Shockley-Read-Hall process and Auger scattering – have been well studied, and previous interpretations have suggested a relationship between these processes and thermal droop. However, the authors found this not to be the case.

“There is a reasonable model that happens not to be true in these high-quality samples, which is that increasing temperature causes Auger and Shockley-Read-Hall processes to become worse, leading to thermal droop,” said author Aurelien David. “In contrast to this reasonable model, we find that neither of these two processes really seem to depend that much on temperature.”

Instead, their work found transport processes to be the dominant cause of thermal droop. Normally, electrons would reach the light-emitting region of an LED and release their energy by emitting photons. However, transport effects can prevent electrons from accessing the light-emitting region or staying there long enough to emit photons. By comparing photoluminescence and electroluminescence measurements of the LEDs at temperatures up to 160 degrees Celsius, the researchers found these transport effects to be thermally driven.

The authors note that improvements in LED structure can help decrease thermal droop below the value found in commercial LEDs. Though they found transport processes to dominate thermal droop effects, further research is required in order to determine which specific transport processes are principally responsible.

Source: “Thermal droop in high-quality InGaN LEDs,” by Aurelien David, Nathan G. Young, Cory Lund, and Michael D. Craven, *Applied Physics Letters* (2019). The article can be accessed at https://doi.org/10.1063/1.5124123.