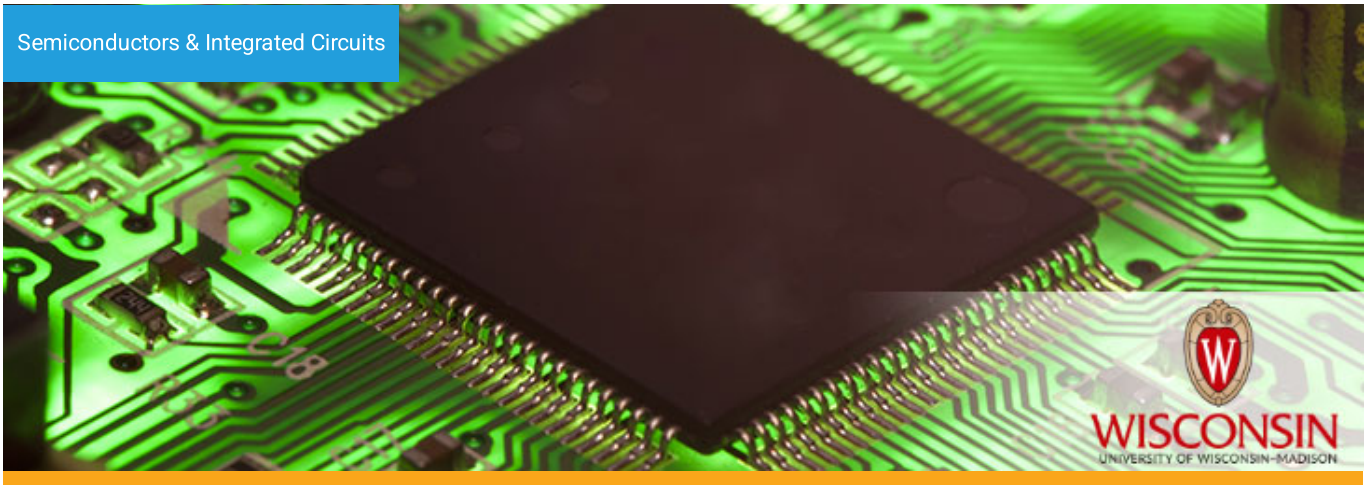

Nitride Based Light-Emitting Diodes with Reduced Efficiency Droop

View U.S. Patent No. 10,297,714 in PDF format.

WARF: P180227US01

Inventors: Zhenqiang Ma, Dong Liu

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a design for power efficient blue and UV LEDs. Simpler to implement than competing methods, the new design provides higher hole injection efficiencies resulting in improved device performance.

Overview

Blue and UV light-emitting diodes (LEDs) are key to modern, energy-saving lighting and are used in a range of applications including efficient home, farm and building lighting, high-speed networking, data storage, smartphones and water purification. They can also be mixed with other LEDs or work with phosphors to make white LEDs. The cost-per-lumen of general lighting LEDs has rapidly decreased in the past decade. However, in the effort to further improve their light emission efficacy and power output, researchers have encountered an elusive issue of “efficiency droop;” i.e., efficiency decreases with increasing injection current density, which severely hinders the cost-per-lumen reduction.

The Invention

UW–Madison researchers have developed a new design for enhanced hole injection that uses heavily doped Si as the hole injector layer and Si/GaN tunneling heterojunctions to enable improvements in light emission efficiency. Two types of LED structures incorporating p-Si nanomembranes (NMs) and n-Si NMs as hole injectors were fabricated and characterized both electrically and optically in reference to the control device with conventional structures.

Compared to the reference LED devices, in terms of optical performances the light output power and normalized external-quantum efficiency (EQE) under the same electrical injection current (50 A/cm^2) were improved for proposed LED structures with p-Si/GaN and n-Si/GaN tunneling hole injection junction by 29 percent and 100 percent, respectively.

Applications

- Energy-saving blue LEDs and UV LEDs

Key Benefits

- Higher hole injection efficiency and improved device performance
- Reduces efficiency droop
- Simple to implement
- Can be adopted more easily than other schemes

Stage of Development

Experimental results demonstrate improved quantum efficiency and mitigated efficiency droop.

Additional Information

For More Information About the Inventors

- Zhenqiang Ma

Related Technologies

- Explore a portfolio of innovations from Zhenqiang Ma.

Tech Fields

- Semiconductors & Integrated Circuits : Design & fabrication

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846