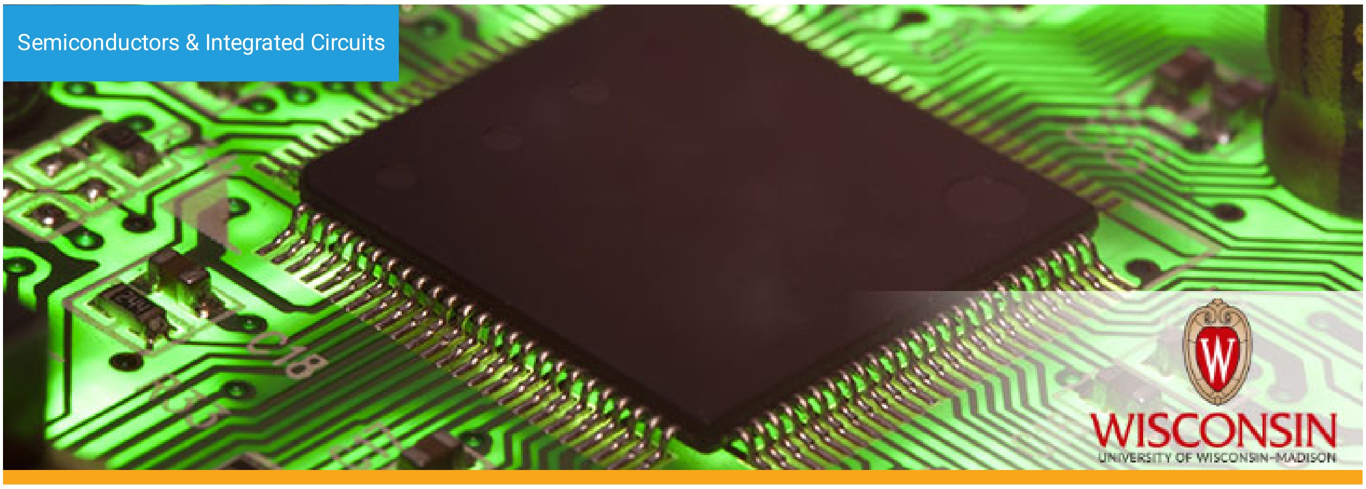

Hybrid Heterostructure Light-Emitting Devices

View U.S. Patent No. 9,425,351 in PDF format.

WARF: P140343US01

Inventors: Zhenqiang Ma, Jung-Hun Seo

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a new method for fabricating high performance light-emitting devices, including blue LEDs and UV LEDs.

Blue LEDs developed using the new method are more than twice as efficient as conventional designs.

Overview

Conventional light-emitting diodes (LEDs) are made of an upper ‘p-type’ layer, a middle ‘intrinsic region’ and a bottom ‘n-type’ layer. Such layered structures are called PIN diodes. Currently, the only material used for fabricating the p-type layer for blue LED PIN structures is gallium nitride – a material that has good n-type properties but poor p-type properties, resulting in low LED efficiency at high current densities. This is partly due to the fact that the p-type gallium nitride material provides fewer holes than electrons provided by the n-type gallium nitride.

The Invention

UW–Madison researchers have developed a method for fabricating high performance light-emitting devices that does not rely on epitaxial growth or wafer bonding techniques. As a result, the p-type layer of the devices can be fabricated from a much wider range of semiconductor materials (e.g., silicon).

The devices feature a multiple quantum well (MQW) PIN diode structure, and are fabricated using a thin film process or interfaced thin-film process. The devices are composed of multilayered semiconductor heterostructures in which layers of material that allow current tunneling through lattice mismatched heterogeneous junctions are sandwiched between the intrinsic active region and the p-type doped charge injection layers.

Applications

- Fabricating light-emitting devices including blue LEDS, LEDS from ultraviolet to infrared, vertical cavity surface emitting lasers (VCSELs) and edge emitting lasers

Key Benefits

- Avoids drawbacks of p-type GaN
- Enables the use of silicon material, which has several advantages over gallium nitride in terms of hole injection
- Boosts efficiency at high current densities
- Cuts fabrication costs
- Many materials can be put together to form the hybrid heterostructures regardless of their lattice and/or thermal mismatch.
- Applicable to blue LEDs grown on any types of substrates including sapphire and bulk GaN (GaN-on-GaN).

Stage of Development

Using their method the researchers have fabricated light-emitting devices for blue and infrared light generation. Their new blue LEDs outperformed conventional designs (bare-chip efficiency at a current density of 100 A/cm2 was increased by more than 110 percent).

The development of this technology was supported by WARF Accelerator. WARF Accelerator selects WARF's most commercially promising technologies and provides expert assistance and funding to enable achievement of commercially significant milestones. WARF believes that these technologies are especially attractive opportunities for licensing.

Additional Information

For More Information About the Inventors

- Zhenqiang Ma

Tech Fields

- Semiconductors & Integrated Circuits : Components & materials

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