Ultrafast Optical Transmitters

Tech ID: 30270 / UC Case 2019-064-0

BACKGROUND

The widespread adoption of visible light communication (VLC) systems based on light emitting diode (LED) transmitters requires the simultaneous increase in efficiency and speed of the optical source. Efficiency is measured by the external quantum efficiency while speed is quantified by the 3dB modulation bandwidth. Most research on the indium gallium nitride (InGaN) system has focused on improving the EQE because this metric, and its dependence on injection current density is an important factor for the growth of LEDs as illumination source for general lighting purposes. The modulation rate of LEDs is however poised to grow in importance due to the need to couple information processing with illumination. An LED with GHz modulation bandwidth, incorporated as light source in an optical transceiver, can enable a plethora of VLC applications: from chip-to-chip wireless communications in data centers to smart automotive lighting, from safe and RF interference-free wireless local area networks in hospitals and offices to underwater optical communications for the exploration, inspection and maintenance of offshore oil

TECHNOLOGY DESCRIPTION

Researchers at UC San Diego have developed designs, methods and structures leading to a nanostructured plasmonic light emitting diode (LED) that simultaneously increases the modulation speed and radiative efficiency compared to conventional LEDs and unpatterned plasmonic LEDs. In the invention, the structure, optimized to ensure its integrability with electrical contacts, couples an InGaN/GaN blue LED with a Ag nanohole grating. Through spatio-temporally resolved photoluminescence measurements, a 40-fold decrease in spontaneous emission lifetime was determined, setting an upper bound to the direct modulation bandwidth in the GHz regime. Additionally, through careful optimization of the plasmonic nanohole grating, a 10-fold increase was demonstrated in outcoupling efficiency relative to an LED with an unstructured plasmonic film. These results bridges the areas of plasmonic metamaterials and III-nitride semiconductors, laying the groundwork for high-speed, high-efficiency blue plasmonic LEDs for applications in visible light communication and beyond.

APPLICATIONS

Visible light communications

ADVANTAGES

Increased modulation speed and radiative efficiency; lower manufacturing cost and better high-temperature tolerance (compared to vertical-cavity surface-emitting lasers “VCSELs” used as high-speed sources in optical communications).

STATE OF DEVELOPMENT

Laboratory demonstration

INTELLECTUAL PROPERTY INFO

This invention has provisional patent application 62/720,763.

RELATED MATERIALS

- Lorenzo Ferrari, Joseph S. T. Smalley, Haoliang Qian, Atsunori Tanaka, Dylan Lu , Shadi Dayeh, Yeshaiahu Fainman, and Zhaowei Liu. Design and Analysis of Blue InGaN/GaN Plasmonic LED for High-Speed, High-Efficiency Optical Communications. ACS Photonics, 2018, 5 (9), pp 3557–3564 DOI: 10.1021/acsphotonics.8b00321 - 08/15/2018

PATENT STATUS

Patent Pending

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OTHER INFORMATION

KEYWORDS

Plasmonics, photonics, LED, optical communication, visible light communication, high-speed

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Communications**
  - Optical

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