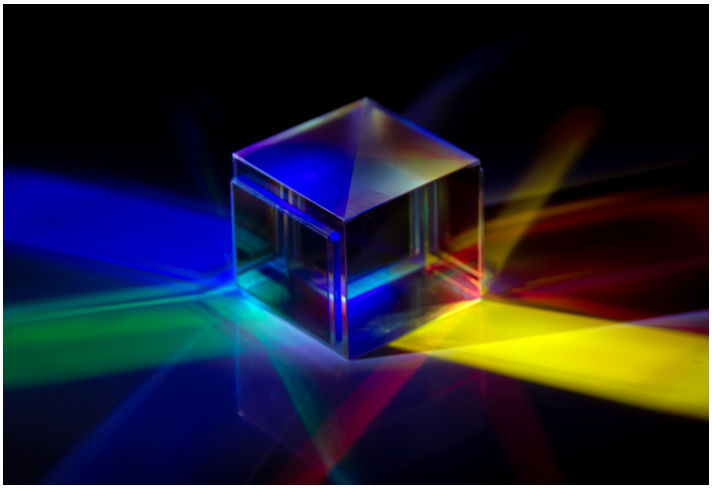
INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

InGaN/GaN Quantum Dot Visible Lasers

Technology Number: 5269



Technology ID

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Category

Hardware

Engineering & Physical Sciences

Semiconductor, MEMS, and Electronics

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Further information

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OVERVIEW

High-efficiency, electrically-injected green laser using InGaN/GaN quantum dots

- Reduces threshold current density and increases efficiency
- Full-color mobile projectors, optical data storage, medical devices

BACKGROUND

Green lasers are essential for full-color mobile projectors, advanced optical data storage, and various medical and military applications. Historically, InGaN/GaN quantum wells (QWs) have been used for green laser emission; however, issues such as large polarization fields and clustering in c-plane heterostructures negatively impact performance. Early approaches on c-plane substrates exhibited high threshold current densities due to the quantum confined Stark effect, which reduces electron-hole overlap. Some success was found using nonpolar or semipolar GaN substrates, but poor indium incorporation during quantum well growth hindered further development. Quantum dots (QDs) offer a promising alternative, with significantly lower piezoelectric fields and better carrier confinement, reducing recombination at defects and improving performance. Nevertheless, until now, there hasn't been an electrically-injected InGaN/GaN QD laser that could effectively balance these demands.

INNOVATION

Researchers at the University of Michigan have developed an electrically-injected green laser based on InGaN/GaN quantum dots (QDs), grown on c-plane GaN substrates. Utilizing a specialized design and fabrication process, including focused ion beam (FIB) etching to create smooth, defect-free laser facets, this technology demonstrates remarkable performance metrics. The laser exhibits a low threshold current density of 1.2 kA/cm^2, an output slope efficiency of 0.74 W/A, and a wall plug efficiency of 1.1%. The superior performance is attributed to reduced polarization fields and enhanced electron-hole overlap in QDs, alongside the precise FIB etching of laser facets. Real-world applications for this high-efficiency green laser include full-color mobile projectors, advanced optical data storage solutions, and various medical and military devices, offering advancements in efficiency and reliability.

ADDITIONAL INFORMATION

Meng Zhang, Animesh Banerjee, Chi-Sen Lee, John M. Hinckley, Pallab Bhattacharya; A InGaN/GaN quantum dot green laser. Appl. Phys. Lett. 30 May 2011; 98 (22): 221104. https://doi.org/10.1063/1.3596436

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