

Thresholdless Nanoscale Coaxial Lasers

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BACKGROUND

Semiconductor lasers generate a large amount of undesired spontaneous emission before starting lasing oscillation, which degrades their efficiency and performance substantially. Therefore, lasers that emit almost no spontaneous emission have long been sought. Such 'thresholdless lasers', - where light output versus excitation power has no obvious threshold characteristic - lasing occurs at extremely low excitation powers. These lasers' superior performance is suited to optical applications.

Currently there are two main approaches to designing nanolasers. The first utilizes dielectric based structures. Dielectrics have low loss at optical frequencies. There are, however, drawbacks in using dielectric-based nanolasers: they are either large in size or their mode extends far out of the gain region, and thus they exhibit poor gain-mode overlap.

The other approach uses metal in a cavity. In recent years, nanoscale metallic, plasmonic, and metallo-dielectric cavities have shown to confine light in ultra-small volumes and to improve the gain-mode spatial overlap. However, existing metal-based nanolasers require high threshold pump power because of the significant absorption loss of the metals at optical frequencies.

TECHNOLOGY DESCRIPTION

Researchers from UC San Diego have developed methods, devices and systems for producing compact solid state lasers with coaxial cavity geometries. This new laser technology operates in a continuous wave (CW) mode at room-temperature or at lower temperatures, and produces thresholdless lasing using a spectrally broadband gain medium. Specifically, this new resonator design leverages the unique properties of nanoscale coaxial structures for harnessing electro-dynamical effects at sub-wavelengths and thus permits the size of the laser cavity to be scaled down without increasing the threshold power required to drive lasing.

APPLICATIONS

Nanolasers are integral for future photonic circuits, by enabling a range of optical applications from on-chip optical communication to imaging, spectroscopy, sensing, and lithography. In addition, by magnifying the quantum properties of the field, they also provide useful tools for in-depth investigations of atom-field interactions.

RELATED MATERIALS

- ▶ [Electrical engineers build "no-waste" laser ScienceNews, 6-Mar-2012 - 03/06/2012](#)
- ▶ [Khajavikhan M, et al. 2012. Thresholdless nanoscale coaxial lasers. Nature, 482, 204–207 \(09 February 2012\) - 02/09/2012](#)

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,989,232	03/24/2015	2012-351

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OTHER INFORMATION

KEYWORDS

Materials science, Applied physics,
Engineering

CATEGORIZED AS

- ▶ **Optics and Photonics**
 - ▶ All Optics and Photonics
- ▶ **Communications**
 - ▶ Optical
- ▶ **Nanotechnology**
 - ▶ Electronics

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