ASEANの科学技術の今を伝える
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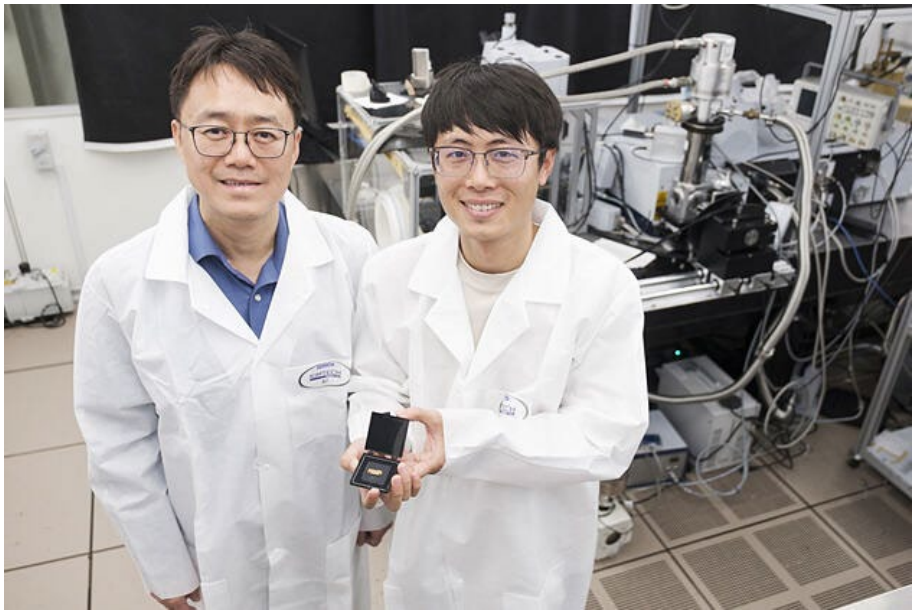
Translated from Japanese

Energy-efficient ultra-compact laser developed by Nanyang Technological University, Singapore

Nanyang Technological University (NTU) in Singapore announced on August 14 that it has developed a new type of ultra-compact laser with high energy efficiency and low power consumption together with an international research team. The research results were published in the academic journal *Nature Photonics*.

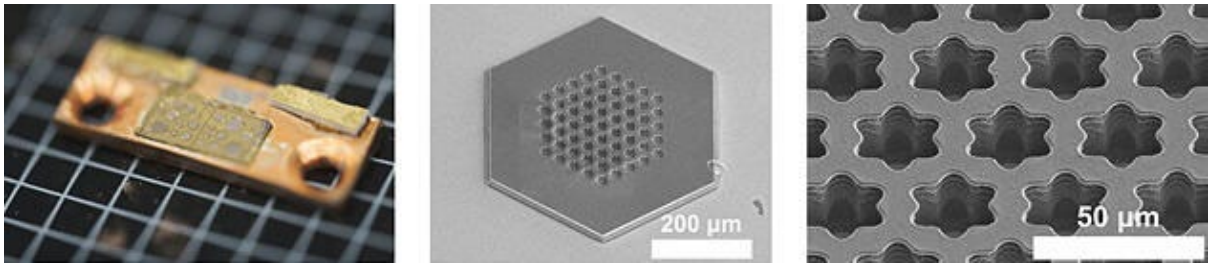


NTU's Professor Wang Qijie (left) and Dr Cui Jieyuan

The developed laser is micrometre-sized, smaller than a grain of sand, and uses a special design that minimizes light leakage. This significantly reduces the energy required to operate compared to conventional compact lasers. The laser emits light in the terahertz range, which is used for 6G communications, and may pave the way for future high-speed wireless communications.

Ultra-compact lasers are expected to be used in a wide range of applications, including optical computing, data centres, high-speed communications, medical image processing, and advanced sensors, but they have had the problem of performance degradation due to light leakage. This laser employs a cavity design that combines the principles of "flat band" and "multi bound states in the continuum (BIC)" with a photonic crystal, suppressing losses due to leakage, scattering, and radiation.

Specifically, by periodically arranging daisy-chain holes in a photonic crystal consisting of a semiconductor material sandwiched between two layers of gold, they prevented light from escaping from the cavity. This could be the "ultimate solution" that can almost completely eliminate three-dimensional light leakage. The resulting laser light is highly directional, and is expected to be used in precision optical applications.



Left: A chip with a hexagonal laser cavity; Centre: The periodic arrangement of daisy-shaped air holes within the laser cavity reduces light loss due to leakage, scattering, and radiation; Right: A close-up of the holes

Professor Wang Qijie, the principal investigator, explained, "Leveraging my more than 15 years of experience in photonic band structure engineering, I recognised that combining flat bands with BICs can effectively confine light and reduce loss." Dr. Cui Jieyuan, the first author, said, "Our laser overcomes the shortcomings of existing compact lasers, expanding its range of applications from next-generation wearable technology to optical computing." Additionally, Associate Professor Zhen Bo of the University of Pennsylvania in the United States praised this innovation, saying, "This is a groundbreaking development in topological photonics."

The researchers will continue to improve the output and integrate it into optoelectronic devices, and are seeking industrial partners to bring the technology to market.

Published paper: Cui et al. (2025) Ultracompact multibound-state-assisted flat-band lasers

https://spap.jst.go.jp/asean/news/250902/topic_na_03.html