Vilnius University

Photonic Crystal Microchip Laser

SUMMARY

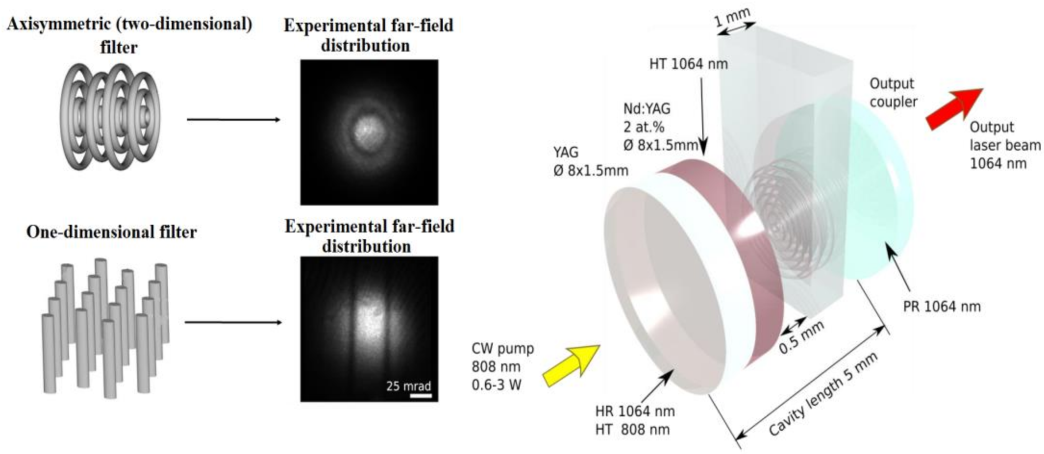
The present technology allows to significantly improve the beam quality and brightness of radiation of a microchip laser, by inserting a specially designed photonic crystal in the cavity of a microchip laser. Technology could be applied in various types of microlasers, including semiconductor edge-emitting lasers and vertical-cavity surface-emitting lasers.

BACKGROUND

Microchip lasers are widely used in material processing, micromachining, light detection and ranging (LIDAR), spectroscopy, etc., where a very compact setup is necessary. Usually microchip lasers suffer from a low beam quality and limited brightness of the radiation, especially in high power operation regimes. The beam quality could be improved, for example, by using optical injection, external feedback, external gratings, external beam manipulation or other techniques, however, this results in a loss of the main advantage – the compactness and simplicity of the laser design.

TECHNOLOGY

The described technology is based on insertion of a specially designed photonic crystal (PhC) in the cavity of a microchip laser and can solve the beam quality and brightness problem for high pump power. PhC can affect the spatial beam propagation, causing such peculiarity as spatial (angular) filtering. PhC spatial filters can provide efficient filtering in extremely short propagation distances (typically around 200 µm). To get powerful beam of good spatial quality (single transverse mode beam) an axisymmetric (2D) PhC filter is utilised. A one-dimensional (1D) spatial filter, filtering in one transverse direction, can also be used to demonstrate the appearance of a beneficial filtering effect. PhC is fabricated via direct laser writing technique, using a femtosecond Yb:KGW laser, in standard soda-lime microscope glass slide. The lateral dimensions PhC filters is 200 µm, and the length is 188 µm. Inserting axisymmetric PhC filter in the cavity of a microchip laser, helps to maintain the same beam quality while having the power of emission almost 4 times higher than the laser without PhC filter (maximum power of 335 mW has been reached during an experiment). Thus the beam quality factor M^2 is reduced by a factor of 2. Due to the PhC filter, the brightness of the emitted radiation is increased approximately by a factor of 3 [1].



TECHNOLOGY READINESS LEVEL

TRL 4 – technology validated in the laboratory.

INTELLECTUAL PROPERTY

Invented in cooperation between Vilnius University, Polytechnic University of Catalonia and Kyiv Institute of Applied Optics: D. Gailevičius, V. Koliadenko, V. Purlys, M. Peckus, V. Taranenko, K. Staliūnas.

PUBLICATIONS

[1] Gailevicius, D. *et al*. Photonic Crystal Microchip Laser. *Sci. Rep.* 6, 34173; (2016). https://doi.org/10.1038/srep34173

BENEFITS

- → Possibility to reach 4 times higher power, while maintaining initial beam quality.
- → The beam quality factor M^2 is twice lower, than alternatives without PhC filter.
- → 3 times higher brightness of the emitted radiation.
- → Due to intracavity PhC filter, there is no need to make laser bigger and more complex.
- → PhC filter is produced from easily obtainable standard microscope glass slide.

APPLICATION

PhC microchip lasers, produced according to the present technology, can be used in various applications:

- → Material processing;
- → Micromachining;
- → Ranging;
- → Light detection;
- → Spectroscopy;
- → Pollution monitoring;
- → Fluorescence measurements.

CONTACTS

Pavel Ragozin
Innovation Manager
E-mail: pavel.ragozin@cr.vu.lt
Phone No.: +370 5 236 6273

Vilnius University Innovation Office
Saulėtekio av. 9, III building
Vilnius, LT-10222, Lithuania
E-mail: innovations@mid.vu.lt
Phone No.: +370 5 236 6273
Web: www.vu.lt/en/business