TECHNOLOGY OFFER

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Institute of Microelectronics and Photonics

A method of manufacturing an active optical fibre and the active optical fibre

Who are we?

Łukasiewicz – Institute of Microelectronics and Photonics, based in Poland (Warsaw), is a part of Łukasiewicz Research Network - one of the largest European organizations for applied research. Łukasiewicz – IMiF operates under the formula Science is Business and its strategy is to play a central role in the innovation process towards R&D for industry and business. Fiber optic technologies are developed by our Photonic Materials Research Group, which conducts research activities on the development of new fiber optic structures, micro-optical elements, transparent ceramics, bioactive ceramics/glasses and special glasses including active glasses.

Patent information

Technology readiness level: 2–3

Title: A method of manufacturing an active optical fibre and the active optical fibre

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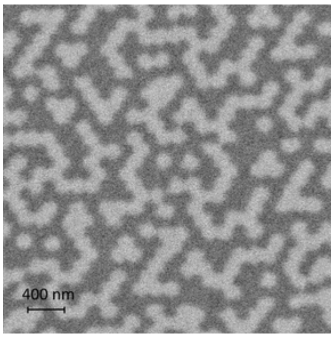
Inventors: Ryszard Buczyński, Dariusz Pysz, Marcin Franczyk, Mariusz Klimczak, Rafał Kasztelanic, Ryszard Stępień

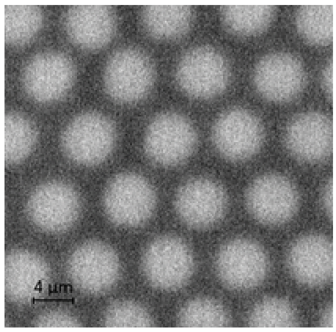
Jurisdictions: United States of America, France, Great Britain, Germany, Switzerland, Poland

The invention relates to a method of manufacturing an active optical fiber, called nanostructuring, in which the fiber core is composed of a few thousand subwavelength rods with similar diameters ordered in the hexagonal lattice. When the rods are made of two or more types of glasses with different refractive indices, their distribution determines the local refractive index experienced by a light beam. Nanostructuring allows to obtain any gradient arbitrary refractive index profile if the size of a single nanostructured component is much smaller than the wavelength, i.e. λ/5. [1]. In active fiber, at least one type of glass is doped with rare earth (RE) ions [2].

a)



b)



The zoomed parts of ytterbium doped (bright areas) a) phosphate nanostructured fibre core with nano-elements of 160 nm in diameter [5], and b) silica nanostructured core preform [2].

[1] DOI: 10.1038/s41598-018-30284-1 A. Anuszkiewicz, et. al., "Fused silica optical fibers with graded index nanostructured core", Sci. Rep. 8, art. 12329, (2018);
[2] DOI: 10.1364/OE.27.035108 M. Franczyk, et al., "Yb3+ doped silica nanostructured core fibre laser", Opt. Express Vol. 27, No 24 (2019);
[5] DOI: 10.1109/JLT.2019.2941664 M. Franczyk et al., "Nanostructured core active fibre based on ytterbium doped phosphate glass", J. Lightwave Technol. 37(23), pp. 5885-5891 (2019).

Technology Summary

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The potential behind the technology

Nanostructuring is a breakthrough technology superior to standard fibre development technologies like MCVD, sintering, and sol-gel synthesis in some aspects. These standard technologies are usually limited to a circular symmetry refractive index distribution or gain profile and method-specific glass materials. Nanostructuring allows shaping refractive index distribution and gain profile with no symmetry limits and is suitable for any type of glass material.

Technology Advantages

Nanostructuring allows arbitrarily shaping refractive index profiles, which is crucial for propagation properties shaping in optical fibers. Together with RI, the gain can be shaped, allowing for control over the lasing/amplifying of active optical fibre. Nanostructuring is a unique method for the mitigation of unfavorable cross-relaxation since two different active glasses can be separated spatially in the core of the active fiber [3]. Another advantage is precise control over refractive index homogeneity Δn < 2×10-4, which allows developing of passive and active large-mode area fiber, which are key for high-power applications [4].

Application

High-power and high-energy fiber lasers are applicable in industries such as automotive, construction, defense, and medicine; dual-wavelength fiber lasers are used for multi-color pump-probe spectroscopy or Raman scattering spectroscopy. The technology related to the invention can be applied to active fibers based on any type of glass matrix, e.g., silica, phosphate, tellurite, fluoride, chalcogenide or others, supporting applications at different wavelength transmission windows.

Collaboration type

License agreement or sale agreement

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[3] DOI: 10.1109/JLT.2022.3199581 M. Franczyk, et. al., "Dual Band Active Nanostructured Core Fibre for Two-Color Fibre Laser Operation", J. Lightwave Techn, vol. 40, no. 21, (2022);

[4] DOI: 10.1109/JLT.2018.2873164 M. Franczyk, et. al., "Numerical studies on large mode area fibres with nanostructured core for fibre lasers", Journal of Lightwave Technology, Vol. 36, No 23, (2018) IEEE/OSA Publishing.