Active Nanostructured Core Fiber for Two-Color Fiber Laser

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The nanostructuring of optical fibers enables the shaping of their passive properties, such as dispersion, modal and polarization parameters [1], and active ones as lateral distribution of gain and photosensitivity [2]. In this work, we study their prospects for simultaneous generation of a high-quality laser beam in two transmission bands using the nanostructuring approach for free shaping of the refractive index distribution and gain for various rare earth ions in the fiber cross-section.

As a proof-of-concept, a nanostructured phosphate glass optical fiber was developed. The fiber core consists of two sets of nanorods with a diameter of 160 nm, doped with Yb^{3+} and Yb^{3+}/Er^{3+} ions, respectively. Since a discrete structure of the core is composed of rods with diameters much smaller than the wavelength, the obtained fiber has an effectively continuous refractive index according to the Maxwell-Garnett model [3]. The fiber core is composed of 6.5 thousand nanorods arranged in a hexagonal structure according to the design pattern to provide uniform gain distribution and single mode high quality laser beam output for both wavelengths (Fig. 1). A 14 cm-long test fiber laser generates simultaneously at wavelengths of 1040 and 1534 nm with the gain efficiency of 23.0% and 9.8%, respectively. Prospects for the development of silica-based two-color fiber laser is discussed.

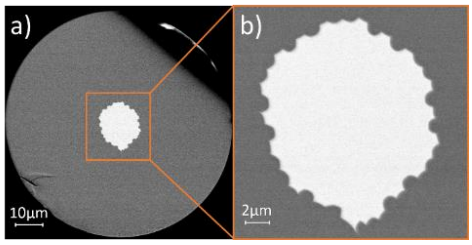

Fig.1. The phosphate fiber with a core formed of 2 types of nanorods doped with Yb and Yb/ Er ions.

[1] A. Anuszkiewicz et. al., *Opt. Lett*. **47**, 401 (2022).

[2] T. Osuch, et al., *Opt. Express* **28**, 14774 (2020).

[3] A. Sihvola, *Electromagnetic Mixing Formulas and Applications* (Institution of Electrical Engineers, 1999).