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.](image-url)