Fiber lasers, born at the same time as groundbreaking inventions of laser and single-mode optical fiber, outperform other sources by high brightness, high conversion efficiency, effective pumping, good cooling, high quality beam, tunability and compactness. Thus, they are suitable for many fields of human activities from dedicate metrology applications, bio-medical diagnosis and therapy to raw power for machining and defense. They represent a kind of "green energy" sources – well in line with the latest ecology trends and energy savings.

Boom in nano-science and nano-technologies has recently brought new opportunities in technology of optical fibers. Doping of fiber cores with metallic and later with ceramics nanoparticles has been investigated resulting with highly doped active glass materials. Completely novel approach to nanostructuring of fiber as a mosaic of nanorods was previously presented bringing free-form optical components finally allowed to consider nanostructured material as a medium responsible thoroughly for light propagation and beam shaping. Nanostructurization opened new opportunities in concepts and development of optical fibers with gradient index nanostructured core, active fibers or large mode area (LMA) fibers for high power applications.

The goal of the project is theoretical and experimental basic research of method leading to specific type of novel nanostructured active fibers suitable for fiber lasers operating simultaneously at dual wavelengths. Two complementary methods will be studied and exploited: method of nanostructuring that allows for arbitrary tailoring of refractive index and gain profile of fibers; and method of nanoparticle doping of preforms that allows for enhanced spectroscopic properties of the rare-earth ions. Novel original findings of novel optical fibers and interpretation of their performance, published in high-quality scientific journals, together with new skills and samples will be the main results of the project. Original findings in the field of fiber lasers are expected thanks to synergy effects resulting from the collaboration between material research scientists and laser physicists across both Institute of Photonics and Electronics, Czech Academy of Sciences (UFE) and Łukasiewicz Research Network - Institute of Microelectronics and Photonics (Ł-IMIF) research teams. The project is particularly focused on theoretical and numerical modelling, optical fiber technology and optical fiber and laser experimental characterization.

The project deals with basic research which results, in general terms, are not expected to be immediately applied. We see potential prospects of application of the results in efficient ("green energy") fiber lasers, laser sources and amplifiers for telecommunications, fiber optics sensors, laser spectroscopy, industrial, medical and security applications. One of the straightforward application is elaboration of method of two wavelengths pulse synchronization in mode-locked fiber laser. Two wavelength pulse synchronization is highly demanded in many applications such as nonlinear frequency conversion, multi-color pump-probe spectroscopy or Raman scattering spectroscopy

Enhancement of current international collaboration with traditional partners and opening of new ones can also be considered as one of the benefits of the project. We expect impact of the project on education in the field of photonics. Ph.D. students will be involved in each proposed project team. Within the project budget we plan bilateral exchange of PhD-students and research fellows engaged in the project. Young researchers will have opportunity to gain experience in technology of nanostructured core fibers in Ł-IMIF or in technology of MCVD preform preparing in ÚFE. Knowledge exchange concerned numerical studies and experimental parts of the project will influence on both groups scientific progress. The cooperation between ÚFE and Ł-IMIF, which is established thanks to this project, is significant for further collaboration, students exchange and further research opportunities.