Popular science summary

Lanthanides based optical fiber technology is one of the main fields of optoelectronics and has enjoyed great interest for the last few decades. Doping optical fibers with compounds of rare earths gives the possibility of producing many active components, among others fiber optic amplifiers - EDFA, radiation sources and fiber lasers. Typically, these fibers are produced from silica due to low attenuation and high mechanical and thermal stability, which allows the transmission and generation of high optical power in the fiber. The luminescent properties of such optical fibers can be modified by introducing one or more rare earth elements thus obtaining the possibility of profiling the luminescence spectrum through co-emission phenomena, energy transfer and conversion phenomena in the energy structure of lanthanides (e.g. energy transfers, cross-relaxation). This makes it possible to significantly extend the luminescent properties of optical fibers in order to obtain radiation emission in the range of 2 μm (due to the low absorption of human tissue, called the eye-safe emission). Such systems have found application in the construction of lasers operating in open space (e.g. environmental monitoring, laser scanners, telecommunications in free space, medicine, optical coherent tomography (OCT) or material processing). From the point of view of the construction of such devices, the single-mode optical fibers with a step profile, refractive index and dopants are not very effective due to the small core diameter. This disadvantage can be minimized by using the appropriate fiber optics structure with a large mode field LMA (Large Mode Area). This is possible by using the photonic structure (optical bandgap) or appropriate profiling of the refractive index of the core. The above research project concerns the development and production of LMA optical fibers in which the optical fiber core is produced by a rare earth doped multi ring structure. Selected lanthanide compounds (thulium and holmium) allow for obtaining the emission in the range of 1.7-2.1 μm safe for eyesight. This also implies the research hypothesis that ultra-broadband emission with flat gain in LMA fiber is possible, achieved thanks to the proposed construction of multi-ring core (MRC) fiber optics. By optimizing the structure of rare earth doped rings and the luminescence excitation system (continuous and pulse operation), it will be possible to extend the emission range to around 2.5 μm. For the production of optical fiber preforms, vapor deposition technology will be used - the MCVD-CDT (Modified Chemical Vapor Deposition - Chelate Doping Technique) method ensuring the control of the structure of this type of structures. The key stage in the development of optical fiber structure will be optical and structural characterization allowing the development and optimization of parameters of the deposition process (MCVD-CDT) and optical fiber production. The above issues constitute a significant contribution to the field of photonics and electronics. Contribution to their development will be a set of basic research on the production, structural and luminescent properties of silica optical fibers (MRC) enabling the construction of new sources of broadband, enhanced spontaneous emission (ASE) and fiber lasers working in the eye-safe range.