Description for the general public

This project is at the forefront of photonics research, focusing on the development of state-of-the-art glass-ceramic active waveguides. The central goal is to engineer waveguides that are operational over a broad spectral range from 1.8 to 3.1 μm, with particular emphasis on the mid-infrared spectrum near 3.0 μm.

At the core of this research is the strategic use of rare earth elements such as ytterbium, thulium, erbium, holmium, and dysprosium. These elements are key to fabricating waveguides that perform effectively within the targeted spectral domain. The practical applications of these waveguides are diverse and impactful, ranging from laser surgery and materials processing to remote detection of atmospheric pollution and optical communications. A significant aspect of this project is its contribution to integrated optics - a field where the integration of various optical elements on a single chip is crucial. This integration, combining active components like lasers and amplifiers with passive elements such as filters and modulators, alongside microelectronics, aims to create optical systems that are not only high-speed and precise but also remarkably efficient. The project's methodology is divided into three primary stages: firstly, the development of thin glass layers through the radio frequency (RF) sputtering technique; secondly, the use of CO_2 laser-induced nanocrystallization for embedding rare earth ions into crystalline phases; and finally, the application of femtosecond laser technology to intricately form core structures in these layers. The end goal is to produce optical waveguides that are highly efficient in the extended mid-infrared spectral range.

By harnessing the unique properties of rare earth elements and utilizing cutting-edge production techniques, this project is set to make a transformative impact in the realms of photonics and integrated optics. The anticipated outcome, innovative glass-ceramic waveguides, holds the promise of revolutionizing microlaser construction and unlocking new opportunities in a range of scientific and industrial applications. This project exemplifies the pivotal role of innovative research in extending the frontiers of optical technology.