

Main aim of this project is to gain new knowledge and know-how about various methods for optical signal amplification in the spectral region between 1650 and 1750 nm using fiber-based amplifiers.

Photonic technologies play important role in various applications, from range finders, through strain and defects localization, to optical communication and health monitoring. An important application of laser-based sensing techniques is trace gas detection, which relies on measuring the absorption of light as it interacts with molecules. Application of compact semiconductor infrared sources allows for highly sensitive and selective detection, also in real-world, out-of-lab environments. In many sensing methods amount of optical power is an important factor that affects their performance. Unfortunately, currently available amplifiers enable signal amplification only in some specific spectral regions. This results in gaps, in which achieving signal enhancement is not simple, or even impossible. A specific example is the spectral range between 1650 nm and 1750 nm. At the same time this spectral region is very interesting for gas sensing community. Relatively strong absorption lines of methane (a greenhouse gas with strong global warming potential) are located between 1650 nm and 1700 nm, hydrogen chloride (highly toxic gas) has its molecular transitions beyond 1725 nm.

Unavailability of optical amplifiers in the spectral region between 1650 and 1750 nm and their potential application to laser-based gas sensing was main motivation for this project.

This project is primarily an experimental effort. Within the two first tasks we plan to study different approaches to signal amplification using fiber-based amplifiers: using novel Bismuth-doped fiber, highly doped Thulium-doped fiber and optical fiber with amplification due to enhanced Raman scattering. Within third task we will combine developed amplifiers with various spectroscopic techniques for laser-based gas sensing. As a result we will show that fiber-based amplifiers can be used to provide gain in the spectral region between 1650 nm and 1750 nm and improve the performance of laser-based sensing techniques.

This project will be realized with a team of four students, two at MSc level, and two at PhD level. Students will be involved in all aspects of the project, from planning the experiments to presenting results during conferences. We are convinced that successful realization of this proposal will additionally help creating new scientific group working in the fields of fiber optics and optical sensing, and will also enable extending existing and establishing new connections with scientific groups in Poland and Europe. It will also significantly contribute not only to the topic of optical amplifiers, but also to related fields, such as optical spectroscopy, ultrashort-pulse generation, optical communication, or medical diagnostics.