Objective of the project

Our objective is to develop novel, robust and low cost spontaneous photoluminescence sources using latest low phonon energy glass technology and doping with appropriately selected lanthanide ions, which provide spontaneous emission in the mid infrared (MIR) wavelength region. The sources will be pumped by the currently available semiconductor lasers thus providing high reliability for the developed sources. Our aim is to perform a comprehensive research on the impact of the available lanthanide dopants, laser diodes, host glass composition and fibre parameters with the intention of maximizing the output power that can be collected by currently available MIR optics and used in applications. We will target primarily the wavelength from 3 micrometre to 5.5 micrometre, which is relevant to gas detection. We will perform both experimental and theoretical research to gain in depth knowledge of the dependence of the spontaneous photoluminescence emitted from low phonon energy glass fibres on the emitting wavelength and power levels of pumping sources, lanthanide ion concentration levels and lanthanide ion composition.

Planned research

We will develop novel state of the art design tools for the developed MIR light sources and use them to identify the optimal parameters of the lanthanide ion doped fibres made of low phonon energy glass. We will then use the results of this research to design the fibres. The fibres will be fabricated using the latest technology. The fabricated fibres will be optically characterised at the Wroclaw University of Science and Technology and used to realise the novel MIR light sources that are the main objective of this project. The realisation of the MIR sources will be aided by the design tools that will also be developed for this purpose within the project.

Reasons for choosing the topic

Mid-infrared (MIR) light sources operating in the range of wavelengths spanning from 3 μm to 25 μm have many potential applications in the fields of medicine, pollution monitoring, biology, agriculture and security. This is because the resonant oscillation frequencies of many molecular bonds fall within MIR wavelength range. For instance, in medicine the application of MIR light would help to improve the effectiveness of cancer diagnostics. A diagnosis of a malignant tumour at an early stage of development is critical in reducing the mortality rate. Another MIR application relevant to increasing the cancer survival rates is the identification of the primary tumour. Improved and more comprehensive diagnostics offered by MIR technology would significantly increase the ability to identify the primary tumour and thus reducing the cancer mortality rate. In the field of agriculture MIR light is very helpful with the plant nutrient deficiency detection and monitoring. A technology allowing for precise and early detection of nutrient deficiency is essential for securing the optimal environment for plants used in food production. Such technology allows for optimal use of fertilisers and thus would prevent an unnecessary pollution of surface and ground water reservoirs resulting from an excessive use of artificial fertilisers. The potential of MIR light for an easy and safe identification of particular molecular bonds can be used for an identification of typical air pollutants and monitoring of CO_2 content in the atmosphere. This would be very helpful in improving the quality of our environment and would also prevent and discourage potential abuse. Also an early detection of air pollutants would improve the safety of people leaving in the vicinity of large chemical factories. For biology MIR light technology would provide novel methods of analysis of biological cells thus furthering our knowledge in this area. Lastly, in the field of security MIR light would allow for construction of effective detectors of explosive materials. Thus MIR technology would help to prevent terrorist acts and improve public security without the need to resort to harsh legislative measures. The key for exploiting the potential benefits of MIR light technology is an availability of low cost, robust light sources, which this project aims at developing.