Pr^{3+} doped chalcogenide fibers for application in MIR light sources

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Recent decade observed significant/dynamic development of light sources operating in mid-infrared (MIR) part of the spectrum. This results directly from wide and continuously broadening area of applications covering environmental monitoring, free-space communication, medicine, quality control systems, imaging and spectroscopy as well as military systems of various kind.

Among materials investigated so far chalcogenide glasses doped with rare-earth ions are considered as one of the most promising candidates enabling operation within MIR spectral range. Thanks to very low phonon energies (<350 cm^{-1}) and high refractive indices, chalcogenide glasses are characterized by significantly lowered probability of nonradiative transitions together with relatively high values of absorption and emission cross sections. The possibility of drawing optical fibers gives an additional advantage - fiber geometry offers easiness of obtaining a single mode operation, high gain and excellent thermal properties combined with compact size of the resulting device.

This work is focused on investigation and comprehensive analysis of the mid-infrared luminescent properties of chalcogenide fibers doped with praseodymium ions, technology of which has been mastered at University of Nottingham [1]. In particular - absorption, excitation and emission characteristics were recorded in room and cryogenic temperatures together with fluorescence dynamics profiles of excited Pr^{3+} levels responsible for optical transitions in MIR. These enabled versatile analysis and discussion of main mechanisms shaping the luminescent properties of investigated materials. The main radiative and non-radiative depopulation mechanisms were identified and the key spectroscopic parameters were determined, giving good starting point for analyzing amplifying and lasing potential of Pr^{3+} doped chalcogenide fibers.

Keywords: praseodymium, chalcogenide glass, optical fiber, mid-infrared

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References

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