Wideband optical amplifier based on multiple dopants co-doping germanate glass

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A Tm:Er:Yb:Ho co-doped germanate glass fiber, pumped at 980 nm, is simulated to design a novel wideband optical amplifier in the range 1440 – 2110 nm.. The optical gain is optimized by using a Particle Swarm Optimization (PSO).
Keywords: Tm:Er:Yb:Ho co-doping, wideband optical amplifier.

1. Introduction

Wideband optical active devices in the wavelength range $\lambda = 1.5 - 2.2\ \mu m$ have attracted a strong research interest, thanks to their wide range of applications, including optical communications systems based on optical WDM techniques for 5G applications, medical diagnostic, remote sensing, and ultra-short pulse lasers development [1]–[3]. These optical devices can be made of different glasses. In addition to fluoride, tellurite and chalcogenide, germanate glasses can be employed. Modeling optical devices made of glasses doped with several different rare earths requires the knowledge of a high number of spectroscopic parameters, because of the several rare earth ion transitions and energy transfer phenomena. This makes their optimization via simulation challenging. In this paper, an innovative Tm:Er:Yb:Ho doped germanate glass [4]–[6] amplifier, pumped at $\lambda_p = 980\ nm$, is investigated. A numerical homemade solver is developed to simulate the amplifier behavior. The used spectroscopic and optical parameters are reported in literature [7]–[8].

2. Numerical results

A step-index fiber is designed to obtain light single-mode propagation, with length $L = 50\ cm$. The input pump power is $P_p = 300\ mW$. Since the optimization is not trivial, a Particle Swarm Optimization (PSO) algorithm is used. It is a general research algorithm, inspired by the behaviour of social organisms in swarms. The four dopant concentrations were optimized to obtain the maximum optical gain in the wavelength range $\lambda = 1440 - 2110\ nm$. The optimized gain G, obtained by PSO algorithm, is reported in Fig. 1.

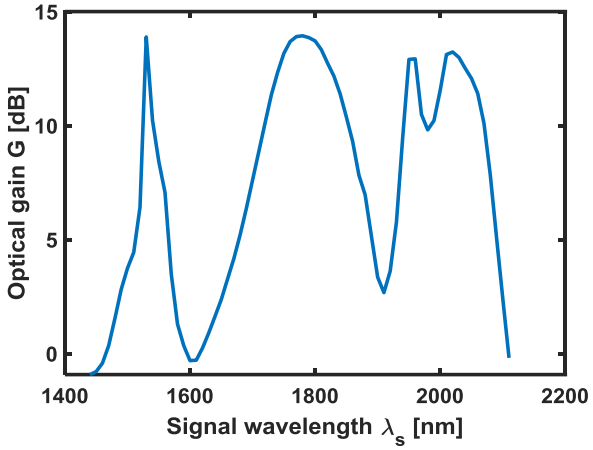

Fig. 1 Optical gain G versus the signal wavelength λ_s.

3. Conclusions

A wideband optical amplifier, based on a co-doped Tm:Er:Yb:Ho germanate glass fiber, is designed. A good optical gain is simulated in a wide wavelength range characterized by different operation regions.

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