Trench-assisted annulus core EDFA for gain equalization of six mode groups

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1. Introduction

Space Division Multiplexing (SDM) is an emerging technology which could resolve the issue of capacity crunch [1]. In few mode fiber (FMF) scheme, orthogonal modes including degeneracy and polarization of fiber carry information data independently. The few mode erbium doped fiber amplifier (FM-EDFA) is key component for the development of FMF based SDM Optical communication system.

We propose the trench-assisted annulus core EDFA which could provide more than 20 dB gain and less than 0.8 dB DMG for six mode groups.

2. Amplifier Design and Simulation

Fiber Design

The proposed fiber structure is schematically shown in Fig. 1. It consists of trench-assisted annulus core and a cladding. The central core and cladding is made of pure silica. The trenches are made of F-doped silica and the graded-index annulus core is made of Ge-doped silica. The purpose of trenches is to enhance the power confinement of signal mode groups of the EDF in the annulus core, which is doped with Er^{+3} ions and works as the amplifying core. Mode profiles of fiber and their effective indices have been calculated using transfer matrix method [2]. The parameters are optimized such that the effective index difference of the adjacent modes is greater than 2.7×10^{-4} which is sufficient to avoid mode coupling due to micro-bending [3].

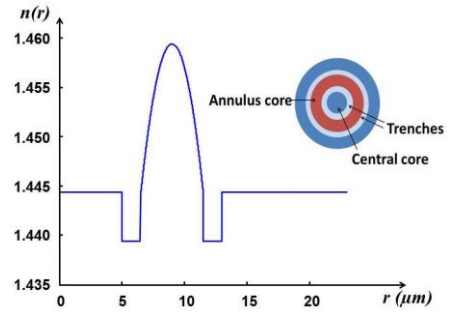

Fig. 1. Schematic of proposed FM-EDFA (annulus core is doped with Er^{+3} ions)

Gain Modeling

The six mode groups of FM-EDF LP_{01}, LP_{11}, LP_{21}, LP_{31}, LP_{41} and LP_{51} with even and odd orientations and two polarizations each, form 22 SDM channels. The input signal power in each orientation and polarization of signal mode groups has been chosen as 30 μW. The gains of FM-EDFA have been evaluated by using mathematical modeling given in Ref. [4]. Erbium ion concentration used is $N_0 = 1\times10^{25}$ m^{-3}. The simulations have been carried out for fundamental mode pumping. The trenches help in increasing power confinement in annulus core and hence help in minimizing the DMG.

Results and Discussion

The variation of gain with FM-EDF length at 1530 nm signal wavelength is shown in Fig. 2. It can been seen that more than 20 dB gain and less than 0.8 dB DMG have been achieved using input pump power of 350 mW and fiber length 2 m or more.

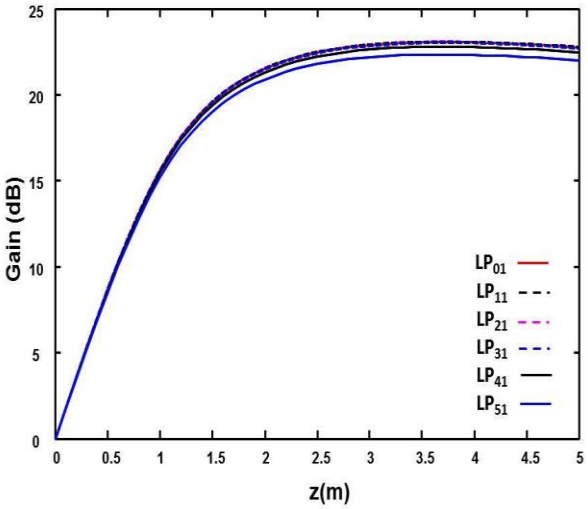

Fig. 2. Variation of gain with FM-EDF length

3. Conclusions

The proposed trench-assisted annulus core EDFA provides more power confinement in doped region and enables to achieve more than 20 dB amplification of six mode groups with very low DMG using fundamental mode pumping. The proposed FM-EDFA would be useful in SDM optical communication system.

References

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