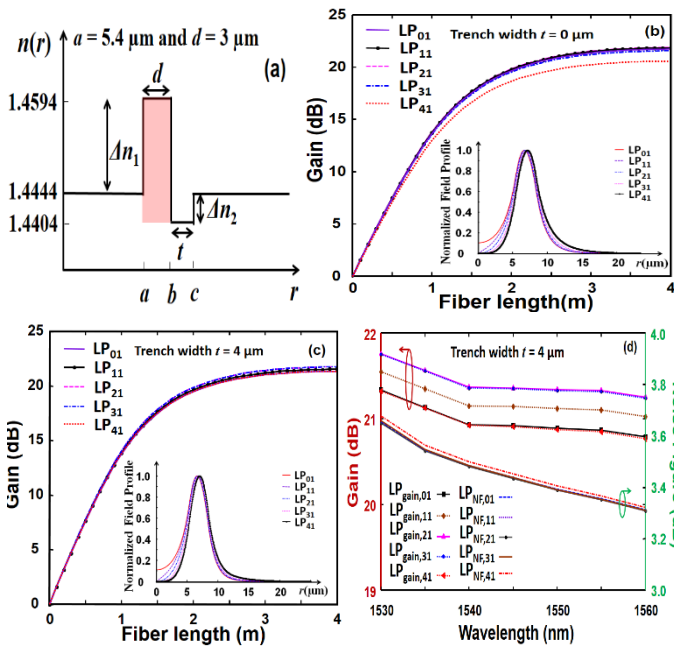


Few-Mode Erbium Doped Fiber Amplifier for Space Division Multiplexing based Optical Communication System

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Statement of the Problem: Few mode fiber (FMF) based space division multiplexing (SDM) technology is the promising solution of capacity crunch issue [1]. To allow the simultaneous amplification of all signal mode groups of FMF, it is necessary to design a few-mode erbium doped fiber amplifier (FMEDFA). The major challenge in the designing of FMEDFA is the gain equalization (i.e. zero differential modal gain (DMG)) without any mode coupling.



Figs: (a) Refractive index profile of proposed fiber (shaded region represents the doping region) (b) Variation of gains of mode groups with fiber length in absence of trench (c) Variations of gains of mode groups with fiber length in the presence of trench of width $4 \mu\text{m}$. (d) Variation of gains and noise figure of five mode groups over C-band.

Methodology & Theoretical Orientation: We propose a trench-assisted ring-core EDFA (as shown in Fig. (a)). The simultaneous amplification of 18 modes of five mode groups has been studied using

this fiber with ring doping and fundamental mode pumping. Transfer matrix method has been used for mode profile calculation [2]. Gains and DMGs of FMEDFA have been calculated through the mathematical modelling given in Ref. [3].

Findings: Fig. (b) shows that more than 20 dB amplification with less than 1.32 dB DMG and mode spacing $\Delta n_{\text{eff}} > 4.9 \times 10^{-4}$ is achieved for fiber length $> 2.8 \text{ m}$. Fig. (c) shows that on introducing the trench of width $4 \mu\text{m}$, more than 20 dB amplification with less than 0.45 dB DMG and $\Delta n_{\text{eff}} > 5.1 \times 10^{-4}$ is achieved for fiber length $> 2.3 \text{ m}$. The results show that trench helps significantly in controlling the DMG. Fig. (d) shows that over the C-band, more than 20 dB amplification of five mode groups with nearly 1 dB gain excursion is achieved with $\Delta n_{\text{eff}} > 5.1 \times 10^{-4}$ and NF $< 3.6 \text{ dB}$.

Conclusion & Significance: The numerical simulations show that trench contributes significantly in minimizing the DMG. The proposed FMEDFA is capable to amplify 18 modes simultaneously with more than 20 dB gain and nearly 1 dB gain excursion. Therefore, proposed FMEDFA would be useful for FMF based SDM optical communication system.

Recent Publications

1. **A. Gaur** and V. Rastogi “Design and Analysis of Annulus Core Few Mode EDFA for Modal Gain Equalization” IEEE Photon. Technol. Lett. 28, 1057-1060, 2016.
2. **A. Gaur** and V. Rastogi, “Design and Analysis of High-Power Segmented-Core Trench-Assisted Yb-free Erbium Doped Fiber Amplifier” Opt. Laser Technol. 95, 46-50, 2017.
3. V. Rastogi, **A. Gaur**, P. Aschieri, and B. Dussardier, “Mode group specific amplification length in an asymmetric LPG assisted few-mode EDFA” Opt. Commun. 382, pp. 13-17, 2017.
4. **A. Gaur**, G.Kumar, and V. Rastogi, “Dual-core few mode EDFA for amplification of 20 modes” Opt. Quant. Electron. 50, 66(1)-66(2), 2018.
5. **A. Gaur** and V. Rastogi, “Modal gain equalization of 18 modes using a single-trench ring-core EDFA” J. Opt. Soc. Am. B 35, 2211-2216, 2018.



Biography

Ankita Gaur has her expertise in the designing of few-mode erbium doped fiber amplifiers. She has designed the fiber amplifiers for space division multiplexing based optical communication system and high power applications. She has completed her post-graduation and Ph.D. degrees from Indian Institute of Technology Roorkee, India. Currently, she is working as Assistant Professor in M. L. V. Textile & Engineering College, Bhilwara, India.

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References:

1. D. J. Richardson et al., Nat. Photonics 7, 354–362 (2013).
2. K. Morishita, IEEE Trans. Microw. Theory Tech. 29, 348–352 (1981).
3. N. Bai et al., Opt. Express 19, 16601–16611 (2011).