Actively Doped Solid Core Photonic Bandgap Fiber

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Abstract: Solid photonic bandgap fibers offer distributed spectral filtering with extraordinarily high suppression. This opens new possibilities of artificially tailoring the gain spectrum of fibers. We present record-performance of such fibers and outline their future applications.

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1. Introduction

Rare-earth doped fibers have become one of the most successful areas in optical fiber technology of all times. This includes EDFA that enabled the telecom revolution [1,2] and more recently high-power single mode fiber lasers that are starting to dominate materials processing [3].

While a number of rare-earth ions exist with different emission spectra there are, however, broad wavelength ranges that have not been accessible for active fibers. This is primarily due to very small emission cross-sections of rare earth ions at such wavelengths and due to inability to suppress amplified spontaneous emission (ASE) at wavelengths of larger emission cross-section. These factors have since the late 1980'ies put hard restrictions on the gain spectrum of active fibers. Although sophisticated co-doping techniques have been extensively studied in order to shape and expand/move the gain profiles, it is not until the realization of solid photonic bandgap (PBG) fibers [4-8] that the possibility to dramatically tailor the gain spectrum of rare-earth doped fibers has become feasible [9].

In this work, we describe the basics of solid PBG fibers (how they operate, their attenuation, PM properties, splicing issues and fabrication methods). Examples of Yb doped versions of PBG fibers are given and we show how their filtering mechanism radically changes the in-fiber gain spectrum. Fibers with 400 dB/m out-of-band suppression are demonstrated which enables strong ASE suppression and record-high amplification around 1150-1200 nm (>130W). Finally, we discuss a number of applications for these fibers, including frequency doubling to 589 nm for laser guide stars.

2. References

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