Er^{3+}과 Tm^{3+} 이 복합 첨가된 실리카 광섬유의 ASE 광원에 대한 특성 평가

Characterization of amplified spontaneous emission light source from an Er^{3+}/Tm^{3+} co-doped silica fiber

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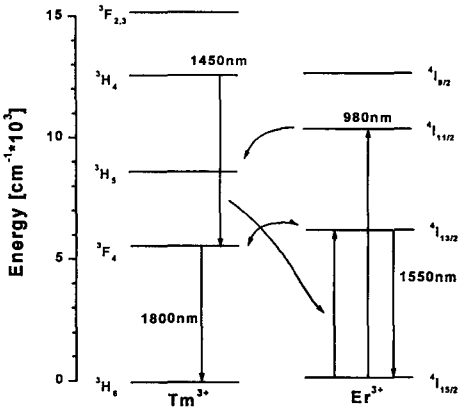
1. Introduction

Incoherent broadband optical sources have been applied in various areas such as a light source for optical device characterization, fiber-optic gyroscopes[1], and spectrum sliced light source in wavelength division multiplexing (WDM) system[2]. To utilize the inherent low loss in silica optical fibers, various types of incoherent light sources are being developed. Among the light sources, the amplified spontaneous emission (ASE) from a rare earth doped fiber has benefits in temperature stability, high output power, low polarization dependence over semiconductor diodes[3]. Recently erbium doped fibers (EDF) have been intensively researched for ASE sources as well as optical amplifiers[4]. The spectrum of ASE from an EDF, however, is limited in the 1520~1560 nm range in conventional configurations. In this letter we described a new broadband ASE source which included both the conventional ASE band of Er^{3+} ion, 1520nm~1560nm and ASE band from Tm^{3+} ions that extends the bandwidth further. For the first time, to the best knowledge of authors, a fiber ASE source based on the energy transfer between Er^{3+} and Tm^{3+} ions in the range of 1460~1550 nm, has been demonstrated using a single 980nm pump laser diode.

2. Experimental methods and results

Figure 1 shows schematic energy level diagrams of Er^{3+} and Tm^{3+}. The energy transfer between these two ions are shown by arrows when pumped at 980nm. Firstly, Er^{3+} ions absorb 980nm pump light, excited to the $^4I_{11/2}$ level, and then relaxed down to the $^4I_{13/2}$ level. Energy of the $^4I_{13/2}$ level in Er^{3+} ions could be transferred to the $^3H_5$ level of neighboring Tm^{3+} ions. Tm^{3+} ions could be also excited to the $^3H_5$ level absorbing 1530nm emissions from Er^{3+} ions. Based on the energy transfer between Er^{3+} and Tm^{3+} ions, when excited by 980nm LD, a broad ASE band from 1460nm to 1560nm is expected, which 1530nm band is from Er^{3+}, and 1450nm band from Tm^{3+}. Based on the energy transfer from Er ions to Tm ions simultaneous lasing at 1550 nm from Er^{3+} and 1800 nm from Tm^{3+} was recently reported by the authors and co-workers[5].

Figure 2 shows the output emission spectra of the 1-m 1200ppm Er^{3+}-6000ppm Tm^{3+} co-doped fiber pumped at 980 nm with 100 mW incident power. The 3 dB bandwidth of the spectrum was measured to be 90 nm, from 1460 to 1550nm. This bandwidth is over twice of that in conventional erbium doped ASE source. In the spectrum, characteristic emission of Er ions is superposed with the emission centered at 1450nm from the Tm ions. The radiative transition $^3H_4$-$^3F_4$ of Tm^{3+} was first observed in silica fiber to the best knowledge of authors.



Figurel. Energy level diagram of Er^{3+}-Tm^{3+} and the energy transfer process under 980nm pumping.

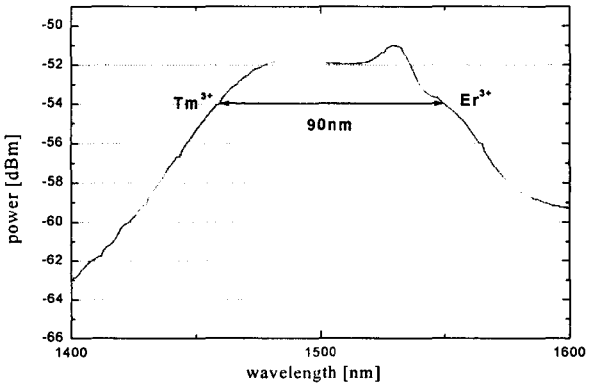


Figure2. Forward ASE spectrum in the Er^{3+}/Tm^{3+} co-doped silica fiber pumped at 980 nm.

Conclusions

We have observed broadband ASE with the bandwidth of 90nm, 1460~1550nm from the Er^{3+}/Tm^{3+} co-doped silica fiber pumped by a 980nm laser diode. The emission is composed with Er^{3+} ion emission ($^4I_{13/2}$-$^4I_{15/2}$) and Tm^{3+} ion emission near 1450nm ($^3H_4$-$^3F_4$). The broad ASE spectrum is believed to result from the energy transfer between Er^{3+}/Tm^{3+}. Optimal concentration of dopants, glass host and pump wavelength are being studied for better output power and broader bandwidth.

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