L-band Watt-level Er/Yb single mode superfluorescent fiber source

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An L band watt-level singlemode superfluorescent fiber source (SFS) is presented. The spectrum covers wavelengths from 1560nm to 1620 nm. The L band SFS is constructed by a low power L band amplified spontaneous emission (L-ASE) seed source, an erbium-ytterbium co-doped fiber (EYDF) pre-amplifier and an erbium doped power amplifier. The output power of 1.2 W is obtained under 5.0 W, 1480 nm pump power.

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1. Introduction

Superfluorescent fiber sources located in the low loss communication window has attracted attention of researchers in the 90s for its usefulness in various areas such as local area networks, fiber optical sensors and fiber optic gyroscopes. SFS's based on rare earth doped singlemode fibers [1-3] are potentially useful in many applications requiring high brightness combined with broad bandwidth and low coherence. Due to demands for expansion of the fiber optical communication window led to the development of L band superfluorescent fiber sources. To avoid lasing action caused by Rayleigh back scattering [4, 9-12] a seed source with low power amplified spontaneous emission (ASE) is used. The high power L-band SFS is constructed by a low power L-band ASE seed source [5-8], a preamplifier and a power amplifier.

2. System

The schematic arrangement of the source is described in Fig. 1. It consists of an ASE seed source, an erbium-ytterbium co-doped fiber pre-amplifier and an erbium doped fiber power amplifier.

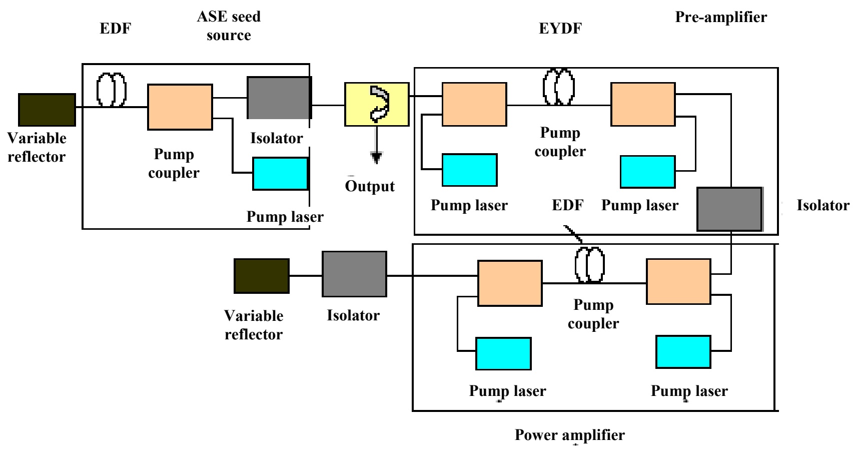

Fig. 1. Schematic of Watt level L-band singlemode SFS.

The fraction of optical power scattered in a section of fiber is given approximately by αL, where α is the fiber loss coefficient and L is the fiber length. A fraction $(NA)^2/(4n^2)$ of this light, typically ~0.005, is captured and guided in the reverse direction. To prevent lasing from this backscattering requires the amplifier to satisfy $G\alpha L\ (NA)^2/(4n^2) < 1$. The ASE source and amplifiers were constructed from 132 μm diameter Er/Yb fiber doped with 2.6×10^{26} m^{-3} of ytterbium and 2.1×10^{25} m^{-3}. To separate the three stages from each other polarization independent isolators are used with >40 dB isolation to prevent back reflections.

3. Results

After constructing the ASE seed source and pre-amplifier, optimized the fiber lengths, a maximum output power of about 4.0 mW is obtained from the seed source. The output power versus pump power (P_{amp}) of the high power L-band SFS under P_{seed}=4.0 mW is shown in Fig. 2. The output power of the SFS increases almost linearly with $P_{amp,}$ and reaches 1.20 W under the pump power of 5.0 W. When P_{seed} decreases from 4.0 mW to 0 mW, the output power of the SFS decreases about 15 %. Obviously the seed source plays an important role in the proposed SFS, although its power is only 4.0 mW. Fig. 3 shows the output spectra of the SFS measured at different pump power (P_{amp}) levels.

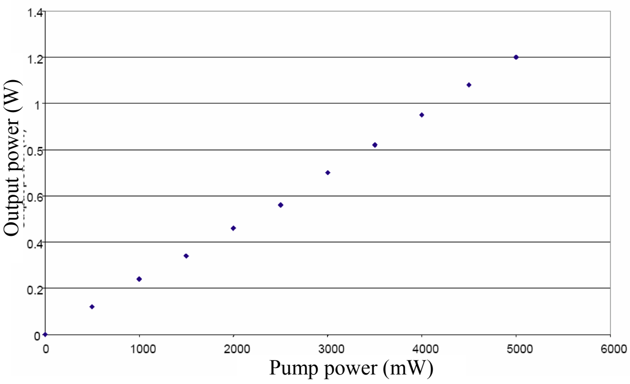

Fig. 2. Output power Vs Pump power of L band SFS.

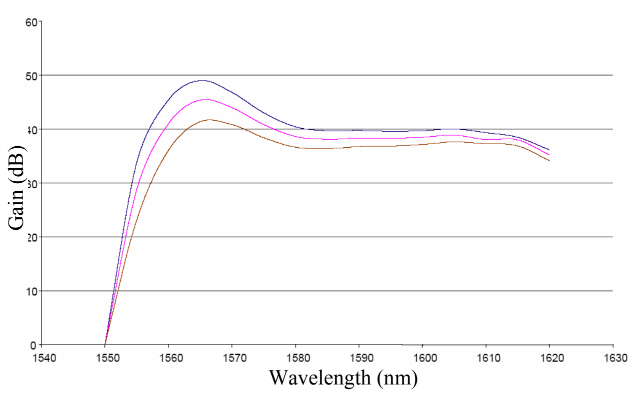

Fig. 3. Spectra of the high power L band SFS with various P_{amp} under P_{seed} =4.0 mW.

It is obvious from the Fig. 3 that the spectral shape changes with an increasing pump power and rises more rapidly in the short wavelength range than in long wavelength range. The expansion of output spectra at high pump power levels is from 1560 nm to1620 nm.

4. Discussion

The utilization of the seed source is very important for high power performance of the superfluorescent fiber source (SFS). It improves output power up to a sufficient level and prevents SFS from lasing. The output power of SFS can not exceed 180 mw without the seed source otherwise laser light will emerge. The gain saturation phenomenon of EYDFA can be utilized to explain the lasing eliminating function of the seed source. However, when lights from the seed source are injected into the EYDFA, the gain will decrease due to the gain saturation effect. More power from the seed source results in a lower gain. When the gain decreases to a level not satisfy the threshold condition, the lasing will be suppressed then.

As compared with SFS in C band the SFS in L band has less risks of resonant lasing. The power of seed source needed to prevent the lasing effect is only about 1 mW in L band SFS. While for C band SFS it is 12 mW. Another important reason to use L band SFS is its relatively more flattened gain spectrum.

5. Conclusions

L band Watt-level Er/Yb single mode superfluorescent fiber source covers broad wavelength range that is from 1560 nm to 1620 nm. Output power of 1.2W has been achieved under 5.0 W, 1480 nm pump power. Although the power of the seed source is only 4.0 mW, it plays an important role in the proposed SFS.

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