A Selective C and L-Band Amplified Spontaneous Emission Source Using a 1×2 Optical Switch *

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We report on a band selective amplified spontaneous emission (ASE) source of an erbium-doped fibre (EDF), which can operate in either the C- or L-band region. The band selective ASE source is realized using a pump conversion technique by a 1×2 optical switch, which makes the ASE source design convert between a backward and a forward pumped configuration alternately. A heavily doped erbium fibre and a 1480 nm laser diode are adopted for this design synchronously to enhance the power of L-band ASE. A power of 16.2 mW for C-band ASE and 11.8 mW for L-band ASE are obtained with a total pump power of 100 mW.

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Incoherent broadband optical sources with low spectral ripples and high spectral intensity based on amplified spontaneous emission (ASE) from erbium-doped fibres (EDFs) have attracted great attention for their various applications in EDFA characterization testing, optical sensor systems, fibre optic gyroscopes and spectrum-sliced sources in the wavelength division multiplexing system,[1−3] etc. As is well known, the broad applications of the ASE source based on EDF have emphasized its importance in modern optical fibre communication systems and optical sensor systems. In the past decades, various designs of ASE sources based on EDFs have been proposed and investigated to improve the performance parameters such as operation bandwidth, mean-wavelength stability, power density and conversion efficiency. In particular, much attention has been focused on the development of efficient-pumping high power broad band sources operated at the L-band or both C-band and L-band for the recent demand for immediate expansion of the fibre-optic communication window from the C-band to the L-band.[4−9]

In this Letter, we propose an ASE source design that utilizes a pump conversion technique that enables us to operate in a selective C- or L-band region with the use of an optical switch. It is the first time that such a band selective ASE source which provides users with the necessary band (C or L) when needed without any form of upgrading or additional module attachment has been suggested and experimentally realized.

The schematic diagram of the proposed band selective ASE source design is shown in Fig. 1. It is composed of two sections of an EDF separated by an optical isolator (ISOI), a 1480 nm pump laser, a 1×2 optical switch, a fibre mirror made by a 3 dB fibre couple, and another optical isolator (ISOII) at the output port used to avoid lasing of oscillation. Two-selective-band operation of the C- or L-band ASE output is determined by the operation state of the 1×2 optical switch. When the optical switch is switched to port 1, the ASE design is a single-pass backward pumped configuration. This configuration ensures that the output ASE spectrum falls on the C-band. When the optical switch is switched to port 2, the backward pump is blocked. The ASE design is a double-pass forward pumped configuration. Thus, the L-band ASE can be obtained because of the low average inversion level of erbium ions. Therefore, by switching the optical switch from port 1 to port 2, the output ASE spectrum can be selected to be either C-band or L-band.

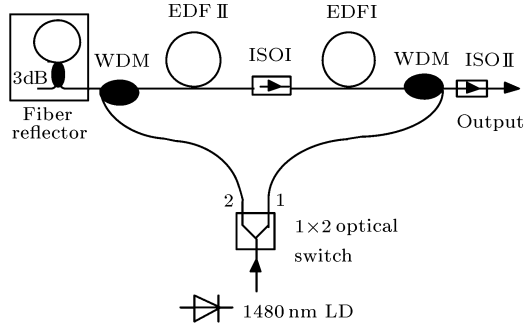


Fig. 1. Schematic diagram of the proposed selective C and L-band ASE source.

In our experiments, the EDF length of the first and second stages is 5 m and 14 m, respectively, of a heavily doped erbium fibre with peak absorption of 22–33 dB/m at 1530 nm (Lucent LRL fibre). Such

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lengths are chosen due to the following reason: the 5-m length of section 1 ensures that it is highly inverted when the optical switch is switched to port 1 then a C-band ASE will be obtained, and the 19-m length of both the sections (namely 14 m length of section 2) ensures that the output ASE spectrum shifts to the L-band when the optical switch is switched to port 2. The output spectrum of the selective ASE source is shown in Fig. 2. With a total pump power of 100 mW, the output powers of the C-band and L-band ASE are measured to be 16.2 mW and 11.8 mW, respectively. It can be seen from Fig. 2 that it has a large ripple around 1532 nm for the C-band ASE, which can be reduced by using a wavelength-dependent loss filter. The L-band ASE is very flat, by optimizing the EDF length. Therefore, a 3 dB bandwidth of about 40 nm for both C-band and L-band ASE will be obtained by adding a C-band wavelength-dependent loss filter at the output port.

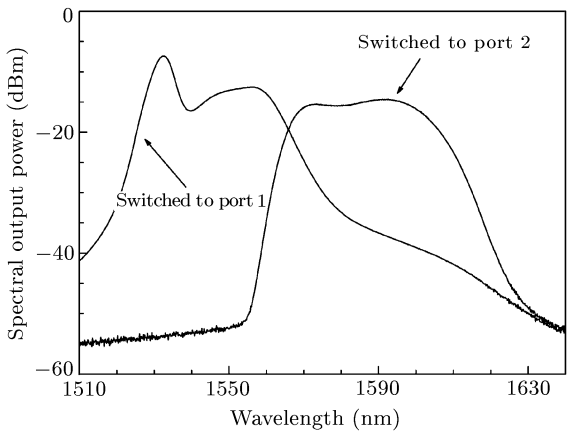


Fig. 2. Output C- or L-band ASE spectrum of the selective ASE source.

It is important to note that the incorporation of a mid-stage optical isolator (ISOI) in this design is the key enabler in achieving the C-band ASE when the optical switch is switched to port 1. The isolator located between the two fibre sections ensures that the backward L-band ASE from the long fibre (EDFII) does not shift the ASE spectrum of the short fibre section (EDFI). An ISO of the central wavelength of 1550 nm and bandwidth of 40 nm is used here. On the other hand, the 1480 nm LD is selected as the pump laser because the 1480 nm LD is more helpful to obtain higher power L-band ASE than the 980-nm pump LD.[10] However, the mid-stage optical isolator is unnecessary if a 980 nm LD is selected as the pump laser because our previous research has shown that the output spectrum of backward ASE is always C-band with a 980 nm LD as the pump laser no matter how long of the EDF is used.[8] Therefore, the ASE design becomes the simpler one of only one-stage configuration with selecting a 980 nm LD as the pump laser. However, its output power of the L-band ASE will be much lower than that by using a 1480 nm pump LD.

In summary, we have experimentally presented a band selective ASE source that can operate in either the C- or L-band region using a 1×2 optical switch. The output ASE band region depends on the operation state of the optical switch. An output power of 16.2 mW for C-band ASE and 11.8 mW for L-band ASE are obtained experimentally. The selective nature of this ASE source design is essential for the dual-band DWDM device characterization and also has potential use as a selective up-stream or down-stream spectrum-sliced coarse WDM transceivers in the emerging metro networks.

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