Rare earth doped phosphate fibre amplifier at 1.5 m for LIDAR

RARE EARTH DOPED PHOSPHATE FIBRE AMPLIFIER AT 1.5 µm for LIDAR

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The research work reports on the design and fabrication of a compact optical fibre amplifier operating at 1.5 µm. A novel Yb/Er co-doped phosphate glass was developed and the optical fibre preform fabricated by rod-in-tube technique.
Keywords: optical fibre amplifier, LIDAR.

1. Introduction

High-power eye-safe laser detection and ranging (LIDAR) sources are used for remote sensing for aerospace and automotive applications [1,2]. They are usually made in master oscillator power amplifier (MOPA) configuration.
Traditional solutions are bulky, heavy and expensive, which does not make them suitable for installation on small/medium unmanned aerial vehicles (UAVs).
Phosphate glass optical fibres allow reducing the length of the power amplifier, thanks to their ability to incorporate high amounts of rare earth ions: this results in high optical gain per unit length [3, 4].
We report on the design, fabrication and characterization of a custom Yb/Er doped phosphate optical fibre, followed by the demonstration of optical gain using a pulsed seed laser operating at 1.5 µm.

2. Experimental

The phosphate core and cladding glasses selected for this work were fabricated by melting a powder batch of high purity (99+%) chemicals inside an alumina crucible at a temperature of 1400 °C for 1 h. A multi-mode optical fibre was fabricated by preform drawing, with the preform obtained by the rod-in-tube technique.
The so fabricated fibre was used for optical gain measurements using a pulsed seed laser with a centre wavelength of 1538 nm. The laser specifications are: 20 mW average power, 0.7 ns pulse duration, 40 kHz of repetition rate which are equivalent to a ~670 W peak power. The seed was connected with a multi-mode and broadband pump laser (centre wavelength of 910 nm) by a pump combiner. The output of the pump combiner (9/125 µm) was butt coupled to the Er:Yb phosphate glass fibre with a 3-axis precision stage. A counter propagating second pump laser (976 nm with a core of 105 µm) was collimated with an aspheric lens of 20 mm focal length. Then, the collimated beam propagated through a dichroic mirror, focused onto the fibre cladding and the amplified seed was reflected by the dichroic mirror and through an optical filter into the power meter.

3. Results

The optical fibre was successfully drawn and featured: core and cladding diameters of 50 and 125 µm, respectively; numerical aperture of 0.11; optical loss of 3.6 dB/m at 1300 nm.
The maximum peak power was measured to be ~1.6 kW, which is equivalent to an optical gain of 3.8 dB. This result was achieved with a 4 cm-long fibre sample (Fig. 1).

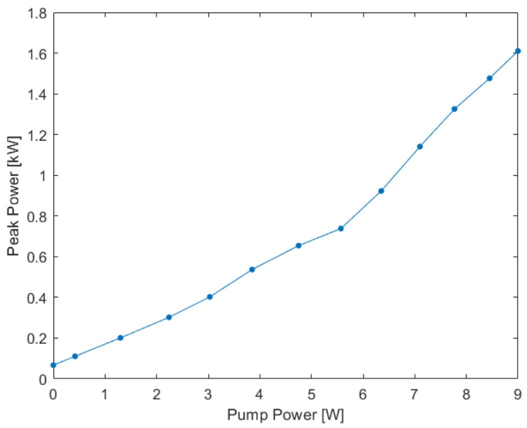

Fig. 1 Laser output peak power as a function of the pump laser diode total power.

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