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Recent advances in Yb^{3+}-doped silica fibre lasers

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Abstract

Recent advances in the operation of Yb^{3+}-doped silica fibre lasers will be presented. including very efficient (up to 80%) cladding-pumped operation at 1020. 1040 and 1140nm. and the development of single-frequency sources for spectroscopic applications.

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Summary

Yb^{3+}-doped germanosilicate fibre has been demonstrated to be a versatile host for laser action at wavelengths from 1 to 1.2μm [1]. It offers many very attractive features including broad absorption (800-1064nm) and emission (970-1200nm) bands. The pump band includes AlGaAs and InGaAs diode wavelengths as well as Nd:YLF and Nd:YAG wavelengths where very high powers are available. The emission band includes wavelengths of interest for specific applications, eg. a 1020nm source for pumping of 1.3μm Pr^{3+}-doped fibre amplifiers and upconversion lasers, a source at 1140nm for pumping of Tm^{3+}-doped fluoride fibre blue upconversion lasers, and single-frequency sources for spectroscopic applications.

The availability of fibre gratings has been a major element in expanding the potential of Yb^{3+}-doped fibre devices [2]. The present work is based on Yb^{3+}-doped germanosilicate fibres, fabricated by the MCVD technique. The host is photosensitive so that gratings can be

written directly into the doped fibre core. Further. very low losses are possible. structures for cladding-pumping schemes can be fabricated and high dopant concentrations can be employed.

We report efficient (up to 60% slope efficiency with respect to absorbed power) operation at 1020nm and 1140nm pumped respectively at 840nm (with the output from a Ti-Sapphire laser) and 1047nm (with the output from a NdYLF laser). To enforce oscillation to occur at these wavelengths. fibre gratings were fabricated in undoped fibre and then spliced to the doped fibre.

While the efficiency with respect to absorbed power is high (~60%). the overall efficiency of these devices is ~30%. limited largely by the launch efficiency of the pump beam into the doped fibre core. However a large improvement in the overall efficiency has been demonstrated through the use of a 974nm cladding-pumping scheme: it is envisioned that this laser will ultimately be pumped with a semiconductor MOPA. The fibre designed for this work was fabricated by the MCVD technique and germanosilicate cores were employed to give a refractive index profile consisting of a single-mode inner core of 4.25μm diameter and an outer core (inner cladding) of 12.75μm diameter. The NA for the inner guide is ~.16 and the NA for the outer guide is ~.15. Ytterbium is added by solution doping and the concentration was measured to be ~500ppm. The pump source was a Ti-sapphire laser operating at 974nm, launched into the fibre using a x5 microscope objective, in order to simulate the focal spot size which would be produced by a semiconductor MOPA focussed within the acceptance angle of the fibre. Very efficient performance (up to 80% slope efficiency with respect to incident power) at 1020, 1040 and 1140nm was obtained. The maximum output power obtained was 475nm (at 1040nm) for 800mW of incident pump power.

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Work is currently in progress on realising singly-frequency operation. initially at 1083nm for spectroscopic applications. using short lengths of heavily-doped fibre. designed to allow direct writing of narrowband gratings into the doped fibre core. The latest results on single-frequency operation will be presented.

References

1. C.J. Mackechnie. P.R. Barber. R.J. Carman. H.M. Pask and D.C. Hanna. CLEO Technical Digest 1993. paper no.CFJ5.
2. J.Y. Allain. J.F. Bayon. M. Monerie. P. Bernage and P. Niay. Electron. Lett.. 29(3). p309-310. (1993).