BISMUTH-DOPED FIBRES FOR NEAR-INFRARED LIGHT SOURCES: PROGRESS AND PROSPECTS

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Abstract: The luminescence properties of Bi-doped silica fibres in the near-infrared region are discussed. Bi-doped fibre lasers and amplifiers and their dependence on the unsaturable loss and excited state absorption are also discussed.

1. INTRODUCTION

Since Fujimoto and Nakatsuka reported the ultra-broadband near-infrared luminescence in Bi-doped silica glass [1], there have been numerous studies on the luminescence properties of Bi-doped glasses and optical fibres [2, 3]. Here, we review our recent results on the luminescence, gain and lasing properties of Bi-doped silica fibre.

2. EXPERIMENT AND RESULTS

A series of Bi-doped fibre preforms with a core glass composition of Ge:Al:SiO_2 was fabricated by the modified-chemical-vapour-deposition and the solution-doping technique with varying Bi, Ge and Al concentrations. The preforms were drawn into fibres with 125 µm outer diameter with higher index polymer coating materials. The fibres showed wide absorption bands at 500, 700 and 1000 nm.

The fluorescence dependence on the pump wavelength was investigated under 915, 976 and 1090 nm pumping. The fluorescence peak shifts towards longer wavelengths and becomes narrower with longer pump wavelengths. The fluorescence decay time under 1090 nm pumping is 750 µsec, but reduced to 670 µsec under 915 and 976 nm. Analysis of fluorescence lifetime showed that Bi ions, which are responsible for 1160-1300 nm emission, possibly sit in different sites. Fibre fabricated by powder-in-tube technology in Al:SiO_2 host showed 1300 nm emission when excited at 800 nm [4].

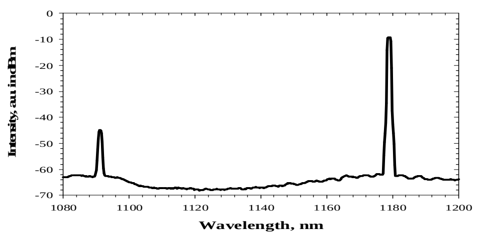

Fig. 1. Output spectrum of Bi-doped fibre laser.

Core pumped Bi-doped fibre in a linear laser cavity was organized by using an Yb-doped fibre laser at 1090 nm as a pump source. Figure 1 shows a typical spectrum of 1178 nm Bi-doped fibre laser. The fibre showed more than 10% of slope efficiency with respect to the launched pump power [3]. The poor efficiency can be attributed to the unsaturable loss present, which is also temperature dependant [5].

The fibres failed to lase when pumped with 915 and 976 nm pumping. The poor efficiency is somewhat explained by the excited state absorption present in the Bi fibre at these pump wavelengths and also the low emission cross-sections at signal wavelengths compared to that by 1090 nm pumping [6].

Optical amplification in a 30 m long Bi-doped fibre was achieved at 1179 nm with a small signal gain of 19 dB. In the power amplifier configuration, a slope efficiency of 16% was achieved at room temperature. It was observed that a suitable heat sink is helpful to increase the gain as well as the saturation output power in the Bi fibre [5].

3. CONCLUSION

Bi-doped optical fibre is a new promising material, which shows luminescence in the 1160-1500 nm spectral bands depending on the host glass composition. Further investigation is necessary to fully understand the near infrared luminescence mechanism in the Bi-doped fibre.

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