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CHARACTERIZATION AND COMPUTER MODELLING OF THULIUM DOPED UPCONVERSION FIBRE LASERS

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The Thulium ion in a ZBLAN host is a promising candidate for the implementation of fibre lasers utilizing several different upconversion schemes. Very efficient 480 nm lasing at room temperature has already been demonstrated with 1120/1140 nm pumping at Amoco [1] and in our group [2] where some new fibres are currently under investigation.

Optimization of the performance requires a quantitative understanding of the system, including degrading effects especially at higher dopant concentrations of up to 10.000 ppm. We have measured not only the laser performance but also the steady-state fluorescence and the fluorescence decay of Tm doped ZBLAN fibres for various pump wavelengths. A detailed computer model, including the three-step excitation scheme as well various energy transfer processes between excited ions, has been developed and brought into good agreement with the experimental data. In this way we have clearly identified several new energy transfer processes. They were found to limit the performance of the 480 nm transition from the $^1G_4$ level, but at the same time they should provide enough population in the $^1D_2$ level for lasing at 455 nm and perhaps even 365 nm with a single 1140 nm pump. Unfortunately, we have also found a broad-band absorption induced by the infrared pump light; this effect seems to depend strongly on the Tm concentration. It prohibited lasing at the mentioned wavelengths so far, but it could well be absent in new fibres which may be available soon.

In this paper we will provide details of the computer model, and highlight those processes which play an important role in the various upconversion laser schemes.

Other groups have achieved efficient lasing at 1.47 μm and 810 nm by pumping similar fibres with 1064 nm [3,4] although the ground-state absorption is very weak at this pump wavelength. To understand this is another goal of our work which is still in progress.

References

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