Abstract

Object of this thesis is the development and characterisation of multi-colour fibre lasers based on Pr^{3+},Yb^{3+}-doped fluoride glass fibres. Inversion is achieved via a multistage pump process using ordinary laser diodes emitting in the near infrared spectral range (typically 180 mW pump power at 840 nm excitation wavelength). Laser emission of more than 10 mW output power at 635, 521 and 492 nm (RGB) and stepless switching between blue and red laser emission is demonstrated.

The fundamental physics and technical aspects of fibre lasers are presented: Light guidance and attenuation in glass fibres, the characteristics of the host material fluoride glass and the operation of optically active fibres are discussed. The properties of the laser-active Pr^{3+}- and Yb^{3+}-ions are described in combination with the multistage excitation process. A discussion of the requirements of laser fibres and other optical components for stable laser operation is followed by explanations about the technical realization of the lasers.

Various fibre parameters relevant for the laser efficiency were determined in extensive measurements and described by theoretical models. This allows numerical simulations of the laser process and a further increase of laser efficiency.

By suitable design of fibre parameters and other optical components the laser output power was optimised especially at the weak, but for applications very important laser transition at 492 nm, so that even for this emission line a differential efficiency factor above 10 % was reached and more than 10 mW laser emission at 200 mW of pumping power is obtained in the red, green and blue spectral range.

A combination of dielectric mirrors mounted on the fibre end faces with external feedback optics together with direct modification of mirror reflectivity by variation of the thickness of a dielectric mirror-layer (adjustable air gap between fibre end face and cavity mirror) enables a variation of the wavelength dependant circulation losses of the laser resonator and to switch continuously between different colours of laser emission or even to achieve simultaneously operation at different wavelengths. Colour switching and simultaneous operation is demonstrated for red and blue laser emission. This method can be used for excitation of further emission wavelengths, so that simultaneous emission at 635, 521 and 492 nm (or other wavelengths) with adjustable colour components can be obtained.

The output power was stabilised and the emission noise was reduced using electronic feedback on the pumping power.