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A TUNABLE Er,Tm,Ho:YLF SOLID STATE LASER FOR SPECTROSCOPIC APPLICATIONS

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Abstract: We developed a cw laser pumped by the 647 nm line of a Kr laser operating at liquid nitrogen temperature. We obtained a 36% slope efficiency with a 30% output coupler. The laser output is 220 mW for 780 mW pump power and the laser tunability covers the 1850 - 1980 nm range.

1. Introduction

The recent development of near-infrared tunable solid state lasers opens interesting perspectives for applications in several different fields, such as monitoring of atmospheric pollutants, medical applications and high-resolution spectroscopy of low-pressure gases. Particularly appealing are the cw lasers based on rare-earth ions in a crystal host. In this paper we describe the development of a tunable cw laser, with a YLF:Er(0.3), Tm(0.1), Ho(0.001) active crystal pumped by a Kr laser and operated at liquid nitrogen temperature. The motivation of this work was to study the features of tunability, spectral purity and intensity of this kind of lasers, to evaluate their potentiality for high resolution non-linear spectroscopy of atoms and molecules.

2. Experimental Apparatus

The laser structure is based on a three-mirror astigmatically compensated resonator. The output coupler is either a partially transmitting mirror with broad-band coating or a grating, useful to tune the output wavelength within the gain curve of the active medium. The crystal is placed at Brewster angle within a liquid nitrogen cryostat. Its dimension are 10 x 5.5 mm with a thickness of 2.2 mm. The pump light is the 647 nm line of a Kr-ion laser and it is coupled to the crystal by a

beam splitter placed at Brewster angle inside the resonator. The crystal is oriented so that its "c" axis is parallel to the pump polarization and orthogonal to the infrared beam polarization: this selection was suggested by the absorption properties of our sample.

3. Results

The output power of the laser was measured with two different output couplers as a function of the pump power. We obtained a slope efficiency of 8% and 36% with 8% and 30% transmitting mirrors, respectively (Fig. 1). The emitted wavelength was 1.91 um, that is a Tm(3+) line; the maximum power we observed was 220 mW with 780 mW of input power, and a threshold of about 100 mW.

We also measured the tunability of the laser by using a grating with 420 gr./mm and the blaze wavelength at 2.15 um as the output coupler. In a preliminary study an overall tunability from 1850 to 1980 nm was obtained: the total range can be covered with two different pump intensities in order to take advantage of both Tm and Ho emission.

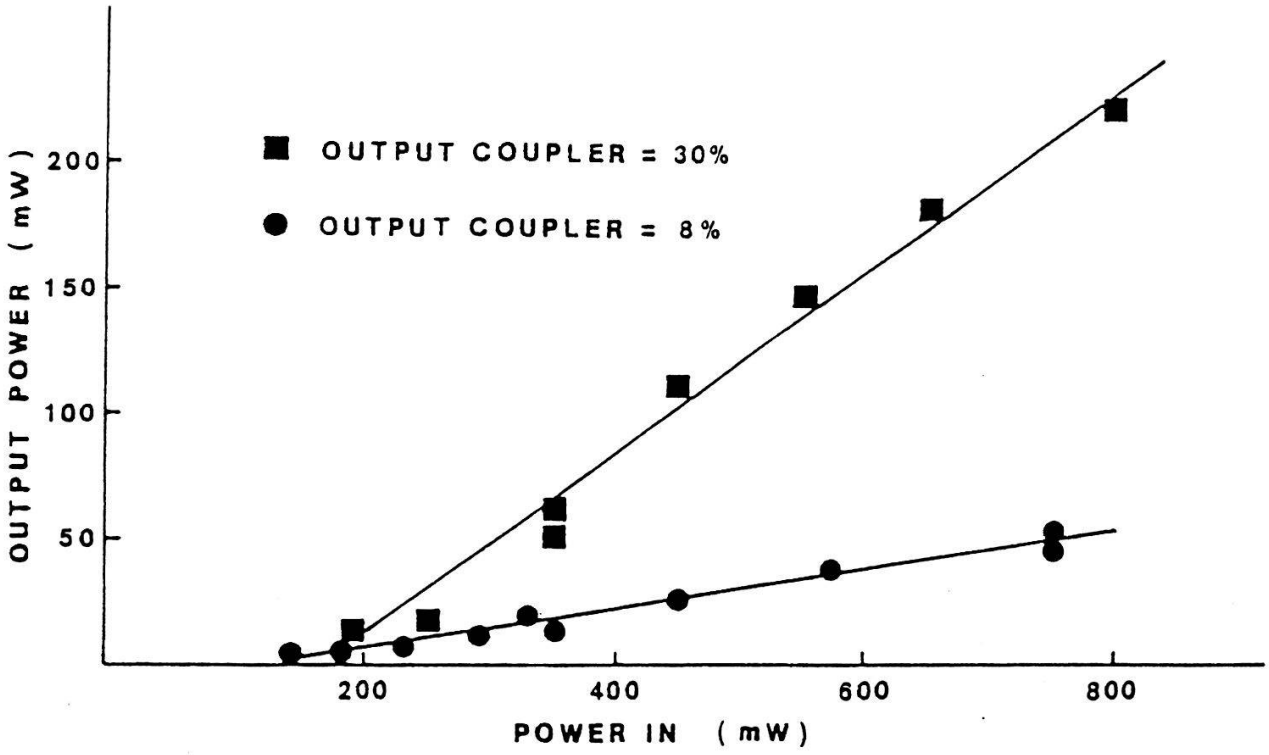

Fig. 1 - Output power of YLF laser versus pump power at two different transmissions of the output coupler.