1.0 μm / 1.5 μm 双波段脉冲光纤激光器的研究

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摘　要:输出波长为 1.5 μm 波段的光纤激光具有“人眼安全”的特点，在遥感、自由空间通信以及激光雷达等军事和民用领域都有着重要的应用价值。并且，随着科学技术的不断发展，相关行业对 1.5 μm 波段脉冲激光输出功率要求也随之增加。为了在提高输出功率的同时保证输出光束的质量，一般由一个主振荡器输出高质量的种子光，然后通过一级或多级光纤放大器来提供输出功率，这种结构一般称为主振荡-功率放大器（MOPA）结构。但是随着泵浦功率的提高，放大自发辐射（ASE）是限制铒镱共掺光纤激光器输出功率提高的一个重要因素。这时，通过输入波长为 1.0 μm 且功率较大的脉冲激光到铒镱共掺系统中后，不仅可以有效的抑制 Yb 波段的 ASE，同时实现了 1.5 μm 和 1.0 μm 的两波段功率分别为 7.4 W 和 3.2 W 的双波段脉冲激光输出。本论文选取了铒镱共掺脉冲光纤激光器作为研究课题，主要进行了以下几个方面的研究：

1. 简要概述了掺稀土元素的光纤激光器发展，并对 MOPA 结构光纤激光器的研究应用和发展进行了简单介绍。

2. 简述了光纤合束器和高功率光纤模场适配器的原理以及利用拉锥熔融法和切断法制作其无源器件的实验过程。

3. 采用主振荡功率放大（MOPA）结构和自制的光纤模场适配器搭建铒镱共掺脉冲光纤激光器的前三级预放大光路系统，优化光路系统并且寻找和解决系统热稳定的问题。

4. 利用 YVTRAN 系统熔接 25/300 铒镱共掺粗光纤，并且通过 25/300 铒镱共掺有源光纤和主振荡功率放大（MOPA）对种子源进行功率放大，同时注入 1 μm 脉冲激光来抑制 Yb 波段的 ASE，当泵浦功率为 26.7 W 时，最终获得 1.5 μm 和 1 μm 输出功率最大分别为 7.4 W 和 3.2 W。

关 键 词:主振荡功率放大器;放大自发辐射;高功率合束器;高功率光纤模场适配器;高功率脉冲光纤激光器

The study on 1.0 μm / 1.5 μm dual-band pulse fiber laser

Abstract: The fiber laser with an output wavelength of 1.5 μm band has the characteristics of ‘hμman security’, which is of important application value in remote sensing, free space communication, military and civil fields such as laser radar. Meanwhile, with the continuous development of science and technology, related industries tend to increase their requirements for the output power of 1.5 μm band pulse laser. In order to improve the output power as well as to guarantee the quality of output beam, we generally get the highly qualified seeds of light by a master oscillator, and then we have the output power provided through the level or multistage optical fiber amplifier, which we know as mainly oscillation - power amplifier (MOPA) structure. However, with the improvement of pump power, amplified spontaneous emission (ASE) became the key factor that restricts the increase of the output power in Erbium ytterbium co-doped fiber laser. In this case, we add a pulse laser with a wavelength of 1.0 μm and a stronger power to Erbium ytterbium co-doped system, which not only

effectively inhibited the ASE of Yb band, but also achieved dual band pulse laser on 1.5 μm and 1.0 μm with band power respectively of 7.4 W and 3.2 W. This paper mainly research on the following aspects, with the Erbium ytterbium co-doped fiber laser selected as the research topic.

1. A brief overview of the development of the fiber laser with mixed rare earth elements and brief introduction on the research and development of the MOPA structure fiber laser was carried out.

2. This paper briefly describes the optical beam splitter and the principle of high power optical fiber mode field adapter as well as the experiment process of passive components by using cone melting and cut off method .

3.By making use of the master oscillation power amplification (MOPA) structure and homemade optical fiber mode field adapter, we set up the three level pre-amplifying optical path system of the Erbium ytterbium co-doped pulse fiber laser while optimizing the optical path system, searching for and solving the problem of thermal stability of system.

4. We use YVTRAN system in welding 25/300 erbium ytterbium co-doped crude fiber, and have the seed source power amplified through the 25/300 erbium ytterbium co-doped and master oscillation power amplification (MOPA) , at the mean time, we add 1μm pulse laser to suppress Yb band ASE, thus with the pump power of 26.7 W, we eventually get the maximum output power of 1.5 μm and 1 μm, which respectively is 7.4 W and 3.2 W.

Key words: the master oscillator power amplifier; amplified spontaneous emission; high power combiner; high power fiber mode field adapter; high power pulsed fiber laser

教师点评：论文设计了一种 1.0μm/1.5μm 双波段脉冲光纤激光器，基于三级 MOPA 结构，搭建了 1.5μm 铒镱共掺脉冲光纤激光器，并和一个 1μm 脉冲激光器共同输入一个铒镱共掺双包层光纤放大器的种子输入端，对其进行双波段功率放大，最终获得 7.4 W 的 1.5μm 激光和 3.2 W 的 1μm 脉冲激光。

论文选题具有较好的应用价值和创新性，难度偏难，文献材料收集翔实，工作量饱满，设计合理，方案可行，数据合理，书写规范，条理清晰。值得一提的是该同学从大二开始就积极进入实验室参与实验项目，通过两年多的锻炼学习，理论基础扎实，具有较强的实验技能，目前已初步形成独立分析问题、解决问题的科研能力，毕业设计中，工作努力，积极认真,很好地完成了毕业设计任务，是篇优秀的毕业论文。