NASA SBIR/STTR Technologies

Efficient in-band diode-pumped Q-switched solid state laser for methane detection

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Proposal No: S1.01-8389

Identification and Significance of Innovation

During Phase I, we developed an efficient Q-switched SSL operating at a wavelength of 1651 nm with the potential for pulse energy >1 mJ at 1000 Hz repetition rate with in-band laser diode pumping. We investigated a variety of gallium garnet gain media, and we demonstrated a lasing peak well-matched to 1651 nm with an optical-to-optical efficiency of >20% using 1468 nm pumping without optimization. We also achieved >1 nm of output wavelength tuning using temperature tuning of a volume Bragg grating in the laser cavity. These results indicate excellent feasilbility for realizing a tunable SLL to enable differential path LIDAR techniques for the detection of methane.

TRL at start and end of Contract: TRL 2 → TRL 3

Phase I Technical Objectives

I. Analyze the optical properties of potential candidates for active media for a 1651 nm SSL; specifically, these low-concentration Er-doped media will include: YGG, YSGG, GSGG and GGG.

II. Investigate potential passive absorbers for a highly compact version of an 1651 nm Q-switched SSL

III. Test the selected Er-doped active media in our existing Q-switched SSL platform (initially developed for Er:YAG).

IV. Design a highly efficient 1651 nm Q-switched SSL

Phase I Work Plan

1.A. Characterize absorption and fluorescence spectra of potential candidates for active media

1.B. Determine optimal absorption band for effective in-band pumping

2.A. Analyze potential passive absorbers near 1.65 μm

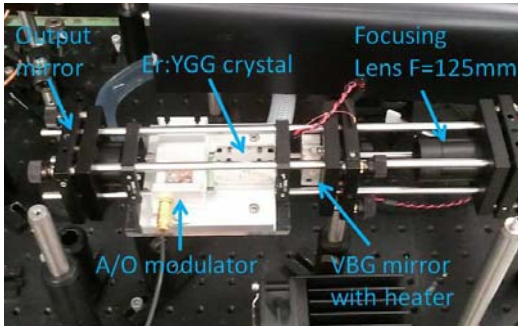
2.B. Test selected passive absorbers in existing laser platform

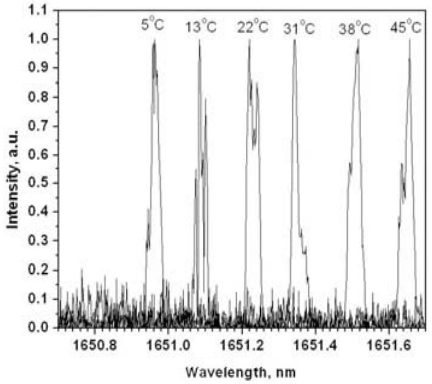
3.A. Characterize dynamic processes of selected gain media in Q-switched operation

3.B. Develop a kinetic model to describe the results of Task 3.A

3.C. Define an optimal Er concentration for the future efficient operation of 1651 nm Q-switched SSLs

4. Finalize design for an efficient 1651 nm Q-switched SSL





Photograph of 1651 nm Q-switched laser prototype [left] and dependence of the spectral position on temperature of VBG mirror [right].

NASA Applications

- LIDAR instruments intended for the measurement of methane in the Earth's atmosphere
- Active remote sensing optical instruments (lidar)

Non-NASA Applications

- Remote gas sensing
- Range-finding and ladar applications
- Commercial lidar systems
- Medical systems
- Material processing

Firm Contact

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NON-PROPRIETARY DATA