THM46 Continuous-wave tunable and *Q*-switched operation at 938 nm of a diode-laser-pumped Nd^{3+}-doped fiber laser

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Fiber lasers have been shown to offer a number of advantages over conventional crystal lasers operating in the near-IR region. The small mode size in the single-mode fiber enables high pump intensities to be relatively easily achieved without associated thermal problems. In addition, cw GaAlAs diode lasers have provided convenient pump sources for fiber lasers, and efficient operation at 1.09 (Ref. 1) and 1.55 μm (Ref. 2) has been demonstrated.

Room-temperature cw oscillation on the $^4F_{3/2}$–$^4I_{9/2}$ transition has been reported previously using a Nd^{3+}-doped single-mode fiber laser pumped by either a cw rhodamine 6G dye laser[3] or a diode laser.[4,5] Also, miniature Nd:YAG lasers operating at 946 nm have been demonstrated, pumped by a rhodamine 6G dye laser or a GaAlAs diode laser.[6] Here we report *Q*-switched and tunable operation of a diode laser-pumped Nd^{3+}-doped single-mode fiber laser operating on the three-level $^4F_{3/2}$–$^4I_{9/2}$ transition at 938 nm.

The experimental configuration of this laser has been described previously.[4] A Sharp LT015 GaAlAS laser diode operating at 823 nm was employed as the pump source. The fiber was characterized by a Nd^{3+} ion concentration of 1200 ppm, a core diameter of 3.4 μm, and a cutoff wavelength of 920 nm. The equivalent step-index N.A. of the fiber was 0.21. The input mirror was chosen to have a high transmission (T = 85%) at the pump wavelength and high reflectivity (R > 99%) at 938 nm, the lasing wavelength. To suppress the buildup of amplified spontaneity at 1.09 μm the input mirror reflectivity was low (R = 3%) at this wavelength. The output mirror had a reflectivity of 57% at 938 nm and 40% at 1.09 μm. No attempt was made to optimize the output coupling.

The cw lasing characteristic obtained is shown in Fig. 1. The slope efficiency was 37% with a maximum output power of 3 mW and a laser threshold of 1.9-mW absorbed pump power. To avoid unwanted residual absorption of the three-level 938-nm emission it was necessary to determine the optimum fiber length. Additionally, if the fiber length was too short, output power was due to insufficient absorption of the pump light. Maximum output power and slope efficiency were obtained for a fiber length of 160 cm (Fig. 2).

Tunable operation was achieved by introducing an intracavity objective and replacing the output mirror with a bulk diffraction grating. The grating had 600 lines mm^{-1} and was blazed at 1 μm. Rotation of the grating enabled tuning of the laser to be achieved. An intracavity pellicle was inserted to couple out the output. The threshold for laser action in this configuration was 6.5 mW absorbed. At an absorbed pump power of 15 mW a tuning range of 40 nm was achieved, as shown in Fig. 3. The maximum output power at 936 nm was 0.2 mW.

Q-switching of this device has also been achieved by inserting an acoustooptic modulator into the cavity. Peak pulse power obtained to date has been limited to ~1 W by the cavity configuration used. However, it is anticipated that powers in excess of 10 W will be readily achievable by simple modification of the cavity.

(Poster paper)

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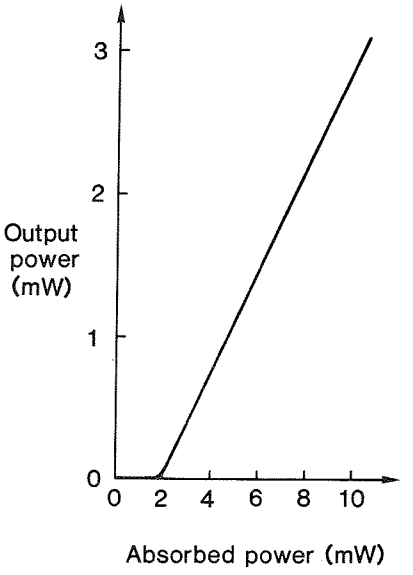
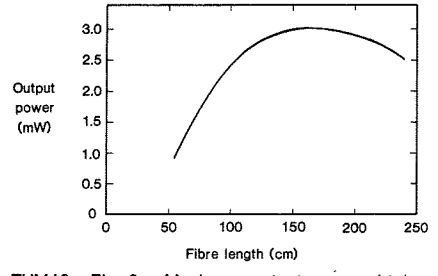
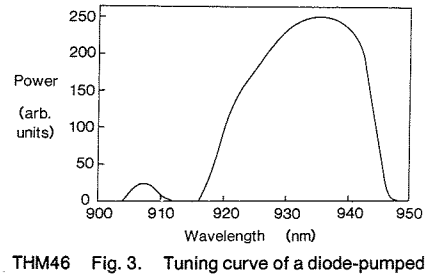


THM46 Fig. 1. Lasing characteristic of a fiber laser operating at 938 nm.



THM46 Fig. 2. Maximum output power obtainable as a function of fiber length.



THM46 Fig. 3. Tuning curve of a diode-pumped fiber laser.