CTuK61 Laser diode-pumped additive pulse mode-locked Nd:glass laser

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There has recently been much interest in the mode-locking of solid-state lasers using the technique of additive pulse mode-locking (APM).[1] This technique has been shown to yield much shorter pulses than active mode-locking in a number of laser systems including Nd:YAG,[2] Nd:YLF,[3] and Nd:glass.[4] Nd:glass is of particular interest for its very broad fluorescence linewidth (~19 nm). Krausz *et al.*[4] have reported pulses as short as 380 fs from an APM Nd:glass laser pumped by a krypton-ion laser. This pump source was required to obtain high enough power from the Nd:glass laser for the APM process to be self-starting. In this paper we report subpicosecond operation of an APM laser-diode-pumped Nd:glass (i.e., all solid-state) laser.

The laser configuration is shown in Fig. 1. The laser cavity was of a standard three-mirror astigmatically compensated design. The active medium was a 2.4-mm thick, 10-mm diameter disk of 4% wt. Nd-doped phosphate glass, mounted in the cavity at Brewster's angle. The output coupling (15%) was chosen to be significantly higher than optimum to enhance the feedback from the external cavity. Four 500-mW broad stripe laser diodes (STC LQ-P-05) were used to pump the laser through both the cavity rear mirror and the turning mirror.[5,6] A maximum power of 270 mW was obtained from this laser, compared with 415 mW with a 5% output coupler.

A portion of the laser output was directed into an external cavity by a 95% reflectivity beam splitter. This was focused into an 85-cm length of single-mode nonpolarization-preserving optical fiber. Using this length of fiber, the optical length of the external cavity was three times the length of the main laser cavity. Coupling in and out of the fiber was achieved using GRIN lenses, which were index matched to the fiber ends. Launch efficiencies of 70% were typically achieved, indicating the good beam quality of the Nd:glass laser. The coupled cavity was completed by a retroreflecting mirror.

We initially used an acousto-optic amplitude modulator in the laser cavity to initiate the APM process. Pulses of 20-ps duration at a repetition rate of 240 MHz were obtained using the active mode-locker with the coupled cavity blocked. Upon unblocking the coupled cavity, the pulses were compressed to a duration of 600 fs. On reducing the radio frequency (rf) power applied to the modulator to zero, it was found that self-starting APM operation was achieved, yielding pulses of subpicosecond duration. Both steady-state mode-locking and simultaneous Q-switching and mode-locking of this laser have been observed. This behavior is currently under further investigation.

We present detailed performance characteristics of the APM laser-diode-pumped Nd:glass laser, including the threshold for the onset of APM operation, mode-locked laser bandwidth, and the useful laser output power.

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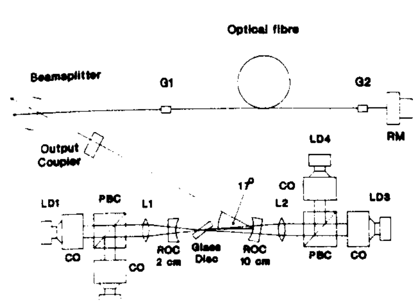

CTuK61 Fig. 1. Schematic diagram of the APM laser-diode-pumped Nd:glass laser: *LD*, diode lasers; *CO*, diode collimating optics; *PBC*, polarizing beam splitting cubes; *ROC*, radius of curvature; *L1,2*, focusing lenses; *G1,2*, GRIN lenses; *RM*, retroreflecting mirror.