High average power picosecond pulses from a fiber amplified diode laser at 1060 nm

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Summary

Many industrial and scientific applications require high-power, short-pulse laser systems. Semiconductor lasers have long proved to be a very convenient and practical technology to generate short pulses at 1550 nm for telecom applications and are also very suitable seed sources for high-power short-pulse erbium:ytterbium based fiber laser systems [1]. Following this approach, recently developed pulsed semiconductor lasers emitting in the 1-1.1 micron wavelength range are today emerging as a promising technology for the generation of short pulses in efficient ytterbium based fiber Master-Oscillator Power Amplifier (MOPA) systems.

Here we demonstrate an ytterbium based fiber amplified pulsed diode system producing pulses with a duration of 52 ps at a repetition rate of 60 MHz with good spectral and spatial characteristics at average powers in excess of 70 W. The fiber MOPA configuration is presented in figure 1. The seed source is a pulsed semiconductor diode generating 60 ps pulses at a repetition rate of 60 MHz at 1060 nm with an average power of 21 μW and ~ 0.1 nm spectral linewidth. The signal was successively amplified by a core-pumped ytterbium doped fiber amplifier (YDFA) and a polarization controlled cladding pumped YDFA to average powers of about 2 mW and 200 mW respectively. The fiber amplifier output was then spliced to a single mode ytterbium doped fiber (12.3 μm core diameter, NA ~ 0.04) cladding pumped in a counter propagation configuration by a 5 W pump diode at 975 nm leading to 3 W of average output power. After propagation through a high power optical isolator, the signal average power becomes 2 W. The single mode beam was then free-space launched into a final high-power cladding pumped fiber amplifier stage using a combination of lenses and dichroic mirrors. The high-power amplifier stage was composed of a large mode area (LMA) fiber pumped by a diode stack at 975 nm. The 8 m long double-clad fiber had a 25 μm diameter, aluminosilicate ytterbium doped core with an NA of <0.05. The silica inner cladding was 400 μm with an NA of 0.48 and was D-shaped. The fiber absorption was 0.6 dB/m at the pump wavelength of 975 nm. Figure 2 shows the output characteristics at the final stage of amplification. The slope efficiency was around 84 % with respect to absorbed pump power. The average output power reached 71 W and the measured pulse duration was 52 ps corresponding to a maximum peak power of 20 kW. At this power level, the laser linewidth was about 0.3 nm (0.05 nm resolution). The beam quality factor (M^2) was measured to be <1.3. This result represents to our knowledge the highest average power obtained with a fiber amplified pulsed diode laser system. We acknowledge the seed source has been supplied under an SPI-Bookham joint development program.

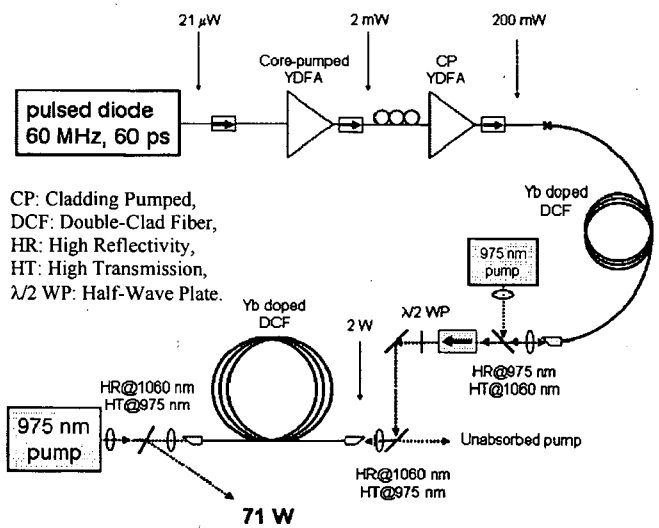

Figure 1. Laser configuration.

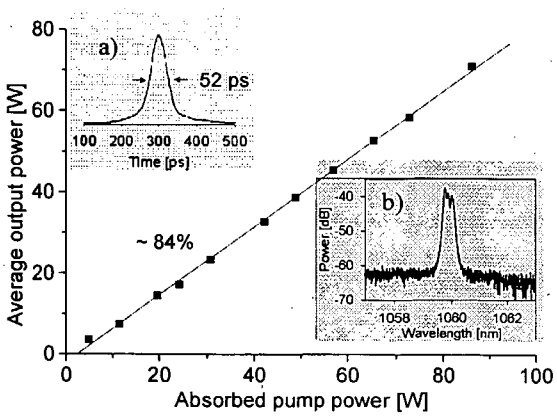

Figure 2. High-power amplifier efficiency. Inset: a) pulse shape and b) optical spectrum at 71 W.

Reference

[1] B. C. Thomsen et al., "60 W, 10 GHz 4.5 ps pulse source at 1.5 μm", *CLEO/IQEC 2004*, paper CMAA (2004).