High-energy picosecond hybrid fiber/crystal laser for thin films solar cells micromachining

J.-B. Lecourt, A. Bertrand, D. Lekime, Y. Hernandez

MULTITEL, Applied Photonics Department, Mons, Belgium, B-7000

250/500 words abstract:

We report on a hybrid fiber/crystal ultra-short pulsed laser delivering high pulse energy and high peak power in the picosecond regime. The laser is composed of a mode-lock fiber oscillator, a fiber pulse picker and subsequent fiber amplifiers. The last stage of the laser is a single pass Nd:YVO_4 solid-state amplifier.

The fiber oscillator is a mode-locked Fabry-Perot cavity for which the mirrors are a 1064 nm FBG (reflectivity = 80%, spectral bandwidth = 0.5 nm) and a high contrast SESAM (ΔR = 54%, relaxation time = 10 ps). The oscillator delivers stable pulse train at a repetition rate of 45 MHz. The pulse duration is 5 ps and the average output power is 3 mW. The optical pulses are then stretched by a chirped FBG to 25 ps. A first fiber amplifier increases the average power to about 100 mW. An acousto-optic modulator based pulse-picker is used for decreasing the repetition rate down to 50 kHz. This latter also induces an overall 33 dB reduction of the average laser signal. Then, a second fiber amplifier is added in order to increase the average output power to about 10 mW which is required for an efficient operation in the crystal amplifier. The Nd:YVO_4 amplifier is pumped with 808 nm multimode laser diodes delivering 60 Watts of average output power. The output power is 5,27 Watts corresponding to 105 µJ pulse energy and 4,21 MW peak power.

The achieved laser benefits from the advantages of fiber technology that can efficiently lead to environmentally stable ultra-short sources in a very compact way; and solid-state technology with Nd:YVO_4 high gain crystal amplification that permits to increase the pulse energy beyond the 100 µJ level (i.e. peak power higher than 4 MW) where optical fibers cannot operate properly because of the induced optical nonlinearities. We believe that this combination of both technologies is a very promising approach for making efficient, compact and low cost lasers compatible with industrial requirements. This laser will be integrated in an ablation system dedicated to the processing of thin film solar cells in the frame of the EU project LASHARE.