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LOWERING THE REPETITION RATE OF MODE-LOCKED ULTRASHORT PULSE FIBER LASERS

Task

Ultrashort pulse lasers are finding an ever increasing field of application in industrial material processing. Frequently, mode-locked fiber lasers are used as a seed source for high-power systems, the repetition rate of which is typically around 50 MHz and is, therefore, too high for many applications in material processing. So that the repetition rate is reduced, actively controlled pulse pickers can be used, which, however, increase the complexity of the system and reduce its efficiency. To avoid this, a purely passive resonator was developed, which directly delivers repetition rates of about 10 MHz.

Method

First, Fraunhofer ILT conducted a theoretical investigation with a semi-analytic simulation; this took into account how dispersion, non-linear effects, gain and losses in the resonator influence the temporal and spectral properties of the pulses.

On the basis of these results, Fraunhofer ILT constructed a passive mode-locked fiber resonator which has a repetition rate of approx. 30 MHz, a pulse energy of 0.5 nJ and a pulse duration of 45 ps. To further reduce the repetition rate, the institute increased the resonator length. For this purpose, different methods were examined, and a hollow core fiber was then used to achieve a high degree of integration.

Results

Thanks to an extension of the resonator, repetition rates around 10 MHz are achieved. At the same time, the other pulse parameters are not affected.

For a single pulse, there are limits in a fiber with respect to the maximum achievable pulse peak power. These limits can be circumvented by using external amplification according to the principle of Divided Pulse Amplification (DPA). As a conceptual study, this was demonstrated for a one-step DPA.

Applications

The demonstrated parameters enable efficient use of this fiber laser in micro and nano production. With the concept under examination, the repetition rate can be adapted to the respective application with efficient laser operation.

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2 *Mode-locked fiber laser
with saturable absorber.*