2 µm ULTRASONIC PULSE LASER WITH SUBPICO SECOND PULSE DURATION

Task

The use of ultrashort pulse (USP) lasers with pulse durations < 1 ps makes the cold processing of a wide range of materials possible, with virtually no heat input into the workpiece. Industrial ultra-short pulse lasers are currently mainly limited to the wavelength range around 1 µm and below. With the help of optical parametric frequency conversion, however, the addressable wavelength can be extended to the IRB range (1.5 to 3.0 µm).

Method

Based on a commercial laser (Trumpf TruMicro 5070 Femto Edition) at 1030 nm, the system presented here generates laser light with a wavelength of 2.06 µm in a two-stage process. First, in an optical parametric generator (OPG), part of the pump power is converted into the longer wavelength signal and idler field ($\lambda_{signal} = \lambda_{Idler} = 2.06$ µm). In an optical parametric amplifier (OPA), this field is further amplified with the remaining pump power. An optional seeding with a narrow-band diode laser can be used to specifically influence the output bandwidth.

Results

Output powers of more than 28 W were generated from approximately 80 W input power. This corresponds to a total conversion efficiency of more than 35 percent. The pulse duration at 2 µm at this operating point is about 600 fs at a pump pulse duration of 900 fs and a repetition rate of 800 kHz. At an optimized operating point, the beam quality M^2 is 1.8 in the horizontal and 2.0 in the vertical direction. In this case, an output power of about 19.5 W was generated.

Applications

The concept presented here demonstrates that efficient high-power frequency conversion of industrial USP lasers is possible with pulse durations < 1 ps in the range of 2 µm. This can be applied to the entire spectral range of 1.5 to 3.0 µm. Thus, USP beam sources can be built, making it possible to process materials with application-specific optimized wavelengths.

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1 Laboratory setup for frequency conversion to 2 µm.

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