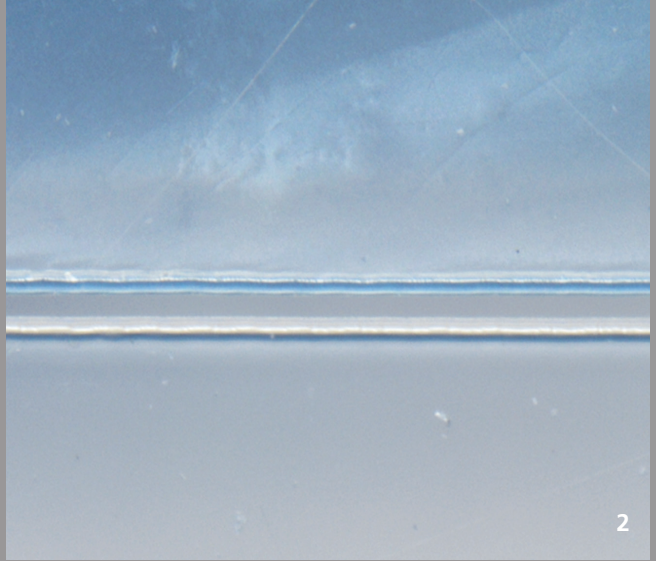
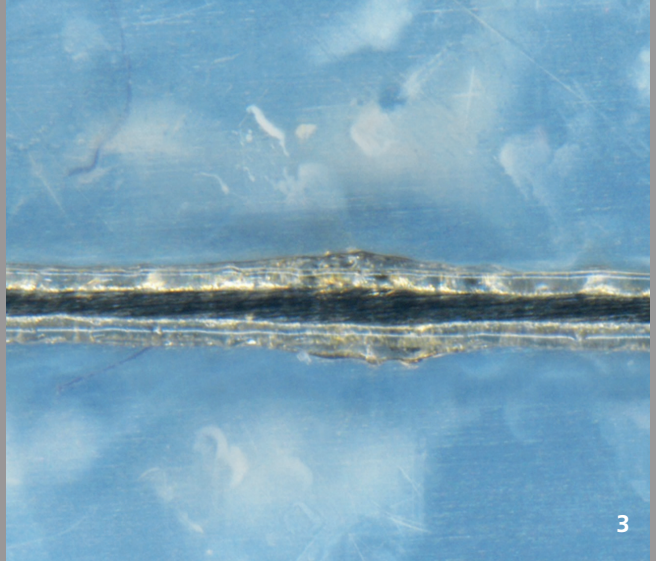


2



3

ULTRASHORT PULSE LASER BEAM SOURCE AT 3.4 µM FOR PROCESSING POLYMERS

Task

The wavelength of a laser can be decisive for the efficiency and quality of laser machining processes. For example, while different polymers show a pronounced absorption at a wavelength of 3.4 µm, this wavelength range is not addressed by commercially established lasers, such as solid-state and fiber lasers. In contrast, the transmission of polymers in the common wavelength range at 0.5 µm or 1 µm is very high, which makes it difficult to introduce energy into material.

Within the joint research project IMPULS, funded by the Federal Ministry of Education and Research, Fraunhofer ILT is investigating high-power INNOSLAB-based modular ps-lasers to make ultrashort pulse laser processing cost- and power-efficient with absorption-adapted wavelengths. For the efficient processing of polymers, the output wavelength of these lasers is specifically adapted to the absorption maximum of the polymers by means of nonlinear frequency conversion.

Method

In the IMPULS project, Fraunhofer ILT is investigating different conceptual approaches for the parametric frequency conversion from 1 µm to 3.4 µm. These consist of an optical parametric generator and, optionally, of one or more downstream optical parametric amplifiers in which PPLN crystals with large apertures are used as nonlinear media.

Results

Based on a three-stage parametric frequency converter, Fraunhofer ILT built a beam source with an average output power of 15 W at an emission wavelength of 3.4 µm, a pulse duration of 10 ps and pulse frequencies of 300 kHz to 1 MHz.

Applications

The beam source developed here can be used for structuring and cutting polymer films, e.g. PE, PEN and PP. The analysis of parameter-equivalent cutting experiments at 1 µm and 3.4 µm wavelengths shows that cuts are possible with 20 to 50 times less power due to the optimized wavelength. In addition, cut edges at a process wavelength of 1 µm show a pronounced tendency to color changes owing to the higher heat input. This does not occur at a wavelength of 3.4 µm or only to a significantly limited extent.

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Cut kerf in PEN film:

2 ... after a laser cut with 3.4 µm wavelength.

3 ... after a laser cut with 1 µm wavelength.