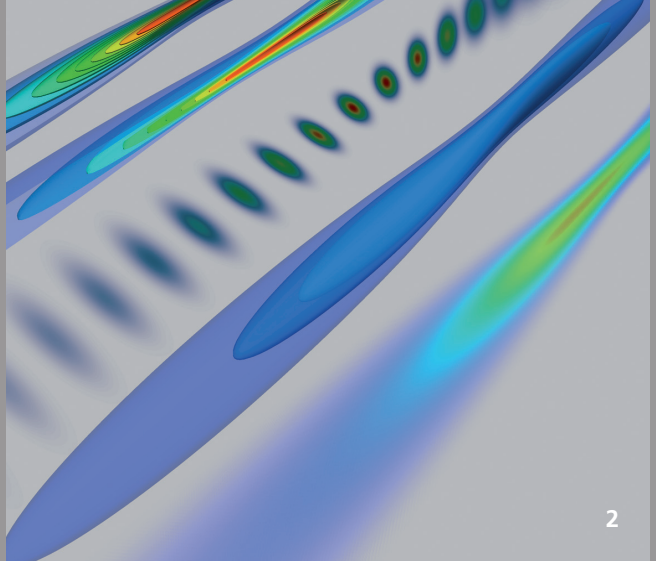

LASER CUTTING WITH ELLIPTICAL BEAM SHAPING

Task

Laser-based precision cutting plays a central role in the metalworking industry. Among the high-power lasers used are solid-state lasers that, when compared to CO_2 lasers, are considerably more efficient. They generate cuts in thick sheets with insufficient quality, however, owing to the unstable process. Research activities in this area aim to improve the quality of the cuts decisively by modifying the beam forming. The highest absorption of the radiation from solid-state lasers ($\lambda \approx 1$ µm) is achieved for metals at an angle of approximately 11° to the surface. If the cutting front is at this angle to the incident laser beam, not only is the energy insertion maximized but melt film dynamics are also stabilized. These dynamics reduce surface roughness and, thus, improve cut quality.

Method

Thanks to suitable beam forming, laser radiation can be better inserted into the material. In particular, by an elliptical intensity distribution in the beam focus, the desired inclination of the cutting front brings about an increase in absorption and, at the same time, a narrow kerf. In computer simulations of roughness formation, elliptical beams are tested with different ellipticity. Based on the results, an optical setup was designed and implemented, which generates a beam shape corresponding to the simulation and allows variable adjustment of the beam ellipticity. In cutting tests on 8 mm thick stainless steel sheets, a broad parameter range was investigated. Moreover, the process was observed with a high-speed camera to determine how the melt film dynamics are affected by the different beam formation.

Result

First experimental results already show that furrow and dross formation is reduced compared to comparable cuts with a symmetrical beam. Thanks to the process observation, the process could be better understood regarding the formation of melt film instability.

Applications

The results of this research are aimed at manufacturers of laser cutting systems and should increase efficiency and create more economical systems. The research was funded as part of the EU project HALO (High Power Adaptable Laser Beams for Materials Processing).

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1 Observation of the cutting process with a high-speed camera.
2 Simulated shape and intensity distribution of an elliptical beam.

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