BUSINESS UNIT
LASER ABLATION AND CUTTING

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LASER BEAM FUSION CUTTING WITH DYNAMIC BEAM SHAPING

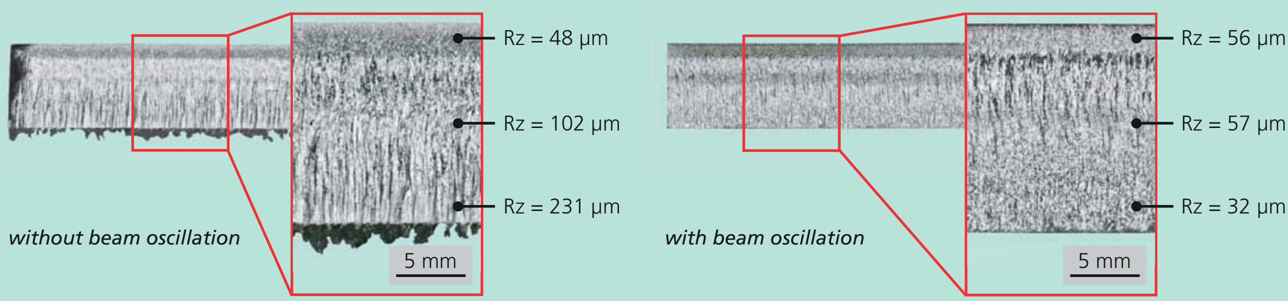
THE TASK

The decisive argument for purchasing a laser cutting machine is the optimal combination of good cut quality, maximum feed rate, low investment and operating costs. Fiber and disk lasers are the leading laser sources for the cutting of thin metal sheets. They offer high cutting speeds and the possibility to use optical fibers. The need for optimization emerges for sheet thicknesses exceeding 4 mm. Compared to CO_2 lasers, the solid state lasers cause an increase in surface roughness and burr formation. In particular, the issue of burr formation has to be addressed by process optimization in order to consolidate and expand the leading position of the solid state lasers as universal laser beam source for the cutting market. One approach to optimize the process is to exploit the incident angle dependence of the absorption on the melt front. It is possible to modify the beam geometry and the intensity distribution to adjust the absorption conditions. Previous approaches worked with static beam shaping for specific applications and were based on adjusting the intensity profile by scaling the laser beam. The aims were to improve process efficiency and/or cut quality. Extensive parameter studies, however, showed only minor improvements compared to standard cutting machines.

OUR SOLUTION

A new approach to influence the cutting process for thick metal plates is based on dynamic beam shaping. The basic idea is to modify the spatial and temporal energy deposition so that the advantages of high focal intensities remain while the absorption increases. For this purpose, a standard cutting head is combined with a high performance scanner system (Fig. 1). The Fraunhofer IWS Dresden developed a special controller solution, which allows for the programming of freely definable functions of the scanner system in the kilohertz range. Numerous degrees of freedom modulate the oscillation of the laser beam (Fig. 3) and add possibilities to the conventional cutting parameters such as laser power, feed rate, focal plane, and gas pressures.

Cut edge of steel X5CrNi18-10, sheet thickness of 12 mm, cut with a 3 kW fiber laser



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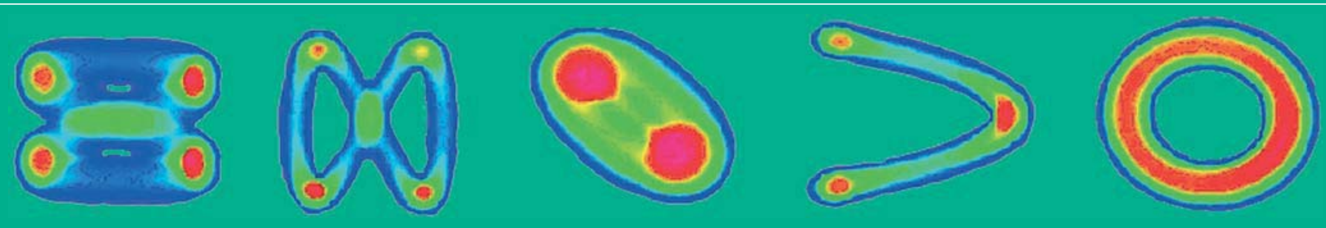

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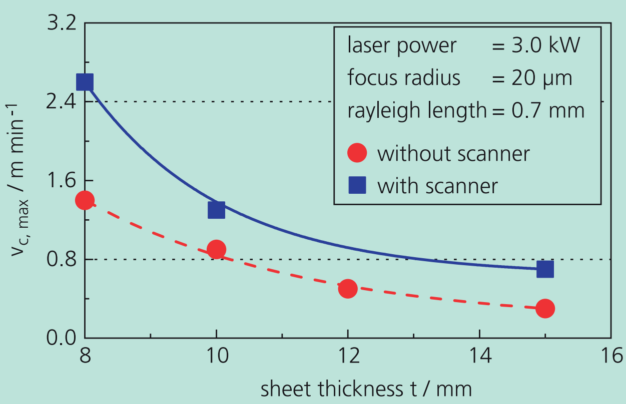
RESULTS

The use of the dynamic beam shaping features clearly improves the cutting performance. Important targets are the achievable cutting speed, the cut kerf geometry and the quality criteria including the surface roughness of the cut edge and the burr formation. Parameter studies with commonly available 3 kW laser sources demonstrate a significant reduction of the burr (Fig. 2) and a changed striation structure. A comparison of the conventionally static and the dynamical beam oscillation with equivalent laser power, exhibits a homogenization of the surface roughness across the entire cut edge as well as a reduction of the absolute roughness depth. Similar results as described for the dynamic beam shaping are only possible with conventional cutting machines if the laser power is significantly increased. In addition to the improved quality and depending on the optical setup it is also possible to increase the cutting speed (Fig. 4) and/or to influence the cut kerf geometry (Fig. 5) with enhanced parallelism of the cut edges. Scanner assisted laser processes achieve good performances for thin as well as thick metal sheet cutting with a single focal length. So far, this was not possible for standard cutting machines without physical adaptation of the focal length. The challenge of the dynamic beam shaping process is the determination of optimized scanner parameters for each application. Available process sensors reduce the analytical effort to adjust the cutting results for customer specific tasks.

Comparison of the cutting speeds during laser beam fusion cutting with and without dynamic beam shaping



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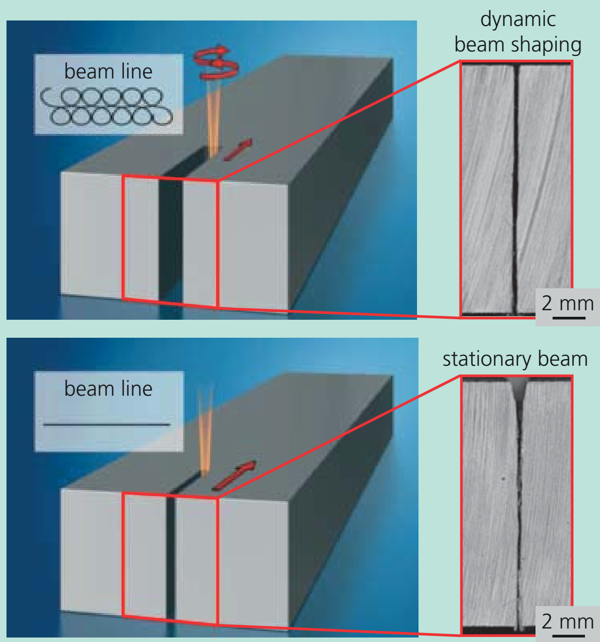
Cut geometry as a function of the oscillation function



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1 *Cutting head with scanner system*

3 *Beam measurement of various oscillation functions*

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