NEW POTENTIAL TO OPTIMIZE LASER BEAM CUTTING THROUGH BEAM FOLDING

Task

In laser beam cutting, efficiency and cut quality are significantly determined by the amount and distribution of the beam energy absorbed in the cut kerf as it forms throughout the process. The innovative type of laser beam shaping presented here – beam splitting and folding – can be used to selectively target and adjust the lateral and axial intensity distribution of the laser beam in the cut kerf. This can significantly increase process stability and efficiency.

Method

The new optical system design makes it possible to split the laser beam into two partial beams and to adjust the relative distance, orientation and shape of the partial beams. Sub-processes that characterize burr and striation formation can, thus, be specifically influenced within the interaction zone, which reaches from the cutting front to the cutting flanks. Supported by simulation and based on a sound understanding of the process, Fraunhofer ILT identified how the beam folding impacts the process, and determined suitable parameter sets for carrying out the experimental analysis. An optical design was derived and transferred to a variable prototype of the optical system. The beam shaping design was tested on a laser cutting unit equipped with a 6 kW disk laser. Stainless and mild steel plates with thicknesses of 10 and 12 mm were used for the experimental tests.

Results

With appropriately adapted beam folding, Fraunhofer ILT was able to produce nearly burr-free cuts right away at process speeds just below the intrinsic cut-off limit and exceeding conventional maximum cutting speeds. In addition, a high quality of the cut was maintained over a wide range of parameters. In particular, this new technology can significantly reduce the well-known strong dependence of the cut quality on the focus position and the process speed. These are the first promising indications that this new type of beam shaping, derived from a well-founded understanding of the process, has considerable potential.

Applications

The concept of laser beam folding offers new chances to reliably produce high-quality cuts at high process speeds. It also represents a solution for static laser beam shaping that can be integrated in a modular way and can unlock previously unimagined potential to optimize not only cutting thick sheets, but also deep welding processes.

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3 Cutting of 10 mm thick stainless steel plate by folded laser beam profile.