Optimization of laser beam cutting with beam oscillation based on high-speed X-ray imaging.

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The optimization of thick metal sheet cutting with a laser at a wavelength of 1 µm includes achieving the highest possible cutting speed with the lowest possible surface roughness of the cut edge. The surface roughness is determined by the striations, which are caused by the melt flow at the cutting front. The maximum cutting speed is given by the amount of molten material per time. This is directly related to the locally absorbed power density of the laser beam on the cutting front, which is defined by the geometry of the cutting front. Therefore, the geometry of the cutting front influences both, surface roughness and maximum cutting speed.
Recently, it was shown that laser beam oscillation can increase the maximum cutting speed and improve the surface roughness compared to cutting with a static beam. In order to investigate this finding, the geometry of the laser cutting front was observed by means of online high-speed X-ray imaging. Fusion cutting of 10 mm thick samples of stainless steel was recorded with a frame rate of 1000 Hz. When the beam was oscillated in longitudinal direction, the maximum cutting speed could be increased by 25% compared to cutting with a static laser beam. In the talk, the influence of oscillation parameters on the cutting speed, the cutting front geometry and the resulting surface roughness will be discussed.