



SAFE LASER CUTTING WITH MINIMALLY INVASIVE POWER MODULATION

Task

Monitoring and controlling the laser cutting process are essential methods for increasing the performance of laser cutting systems. Using them can result in controlled and safe processes that can be managed stably even with low reserves. An essential prerequisite is reliably diagnosing the process and system state in a wide parameter and state space. Even or especially under varying process conditions, it must be possible to assess these states reliably with simple diagnostic tools. The minimally invasive power modulation (MIPM) method developed at Fraunhofer ILT offers excellent possibilities for this.

Method

Special modulation patterns of the laser power are used to induce responses in the process signal, which are detected by a simple, coaxially observing photodiode. Analysis of the transfer behavior from the input signal (laser power) to the output signal (photodiode) provides a much more accurate and robust identification of the process state than an evaluation of the photodiode signal of a non-modulated process using classical signal analysis methods. For example, the process responds in a significantly different manner to power changes in a critical process state near the maximum speed than in a stable state. The modulation strength can be set so low that there are no

disturbing effects that reduce the quality of the cutting result. The modulation patterns are generated dependent upon the cutting parameters or regulated by the feedback of the photodiode signal.

Results

With the aid of the characteristic response patterns of the photodiode signal, Fraunhofer ILT is able to reliably monitor the cutting success even in the case of process signals that cannot otherwise be evaluated unambiguously, as is typical, for example, in high-speed cutting. Fast process data processing based on an FPGA makes short response times possible: in the range of less than one to a few milliseconds in real time. Standard cutting processes also benefit from MIPM, as critical states are announced in time and proactively avoided.

Applications

In the current stage of development, the method is used to monitor laser cutting systems and will be extended to process control in the future by means of feedback on the process parameters. Machine learning algorithms play a central role as they will be applied to analyze the complex characteristic patterns. It is also planned to transfer the method to laser welding.

Contact

Dr. Frank Schneider, Ext.: -426
frank.schneider@ilt.fraunhofer.de

Dr. Dirk Petring, Ext.: -210
dirk.petring@ilt.fraunhofer.de

1 *Development on process monitoring
with minimally invasive power modulation.*