High Throughput and High Quality Laser Ablation, Texturing Techniques, Light Manipulation and Control in Industrial Processes with Ultra-Short Pulsed Lasers

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Abstract

This lecture deals with industrial application of ultrashort laser pulses. Part I discusses process efficiency, its optimization and effects limiting the power scale up whereas strategies to achieve high throughput are presented in Part II.

Part I: High throughput and high quality laser ablation and texturing techniques with pulsed lasers

Ultra-short pulsed laser systems are often the tool of choice if highest quality is demanded in laser micromachining. Especially for metals the laser ablation process shows an optimum going with highest efficiency and quality. This point is directly linked to the threshold fluence and the energy penetration depth for the material to be machined and depending on their part from the wavelength and the pulse duration. As a rule of thumb shorter pulses and wavelengths lead to higher efficiencies. However, the main effect hindering an efficient scale up to high throughput is the fact, that at this optimum point the desired pulse energy i.e. fluence is only moderate and therefore high average powers used for high throughput demand high repetition rates where heat accumulation and shielding effects can become a serious issue. We will discuss the requirements and limits of an efficient scale up process to high throughput.

Part II: Light manipulation and control techniques in industrial processes with pulsed lasers

Based on the insights of the previous talk adapted strategies to achieve high throughput are demanded. Beside fast scanning also energy splitting, either in time i.e. with pulse bursts or in space with multi spots can be applied. Direct beam forming with either a diffractive optical element or a spatial light modulator offer the possibility to work with higher pulse energies and therefore reduced laser repetition rates. Efficient processes like optical stamping or multi pulse drilling on the fly can be realized by combining this kind of beam forming with synchronized scanning. By expanding the synchronization to additional mechanical axes this technique can e.g. be used to machine embossing rollers or tubes.