# High Throughput and High Quality Surface Processing with Ultrafast Lasers

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Ultrafast lasers are the tool of choice for high quality surface structuring applications. As the average power of industrial ready ultrafast lasers is just entering the multi 50 W level the demands on the scanning system technology are emerging. Recently we demonstrated a significant reduction of the machining time with fully synchronized galvo-scanners by adapting the scanning strategy and optimizing the trajectory. But with these devices the scale-up is limited and alternative approaches are demanded for even higher throughput.

For single beam applications polygon line scanners are an attractive tool offering marking speeds exceeding 800 m/s [1]. Removal rates above 40 $mm^3$/min have been demonstrated on copper and brass with average powers in the range of 300 W [2]. However, the scale-up process is limited due to shielding effects [2] and/or heat accumulation [3] as repetition rates up to a few 10 MHz have to be used. A way to achieve removal rates in the range of 15 $mm^3$/min on copper by combining a polygon line scanner with a roller in application of machining large cylindrical surfaces for embossing rollers has been presented [4].

Using multi beams corresponds to an enlarging of the spot size offering the possibility to work at higher pulse energies and reduced repetition rates. A similar effect can be achieved with a diffractive optical element (DOE) which can be used for repetitive structures. This limitation to repetitive structures could be overcome by a dynamic adaption of the intensity distribution in the focal plane as e.g. offered by a spatial light modulator (SLM) [5].

A combination of an SLM or DOE with a synchronized scanning system could offer a solution to work with multi 100 W of average power in future, but further investigations are still needed to find the optimum combination and machining strategy.

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