Ultrashort laser processing with MHz bursts: A new approach to improve production throughput in industrial applications

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Industrial laser micro-machining technology is increasingly gaining ground as the process of choice for the manufacturing of advanced engineering components with micro-scale features. The pressing need from various industrial sectors, e.g. electronics, automotive and aerospace, for providing not only high precision and quality, but also high throughput, has propelled the rapid development of ultrashort lasers emitting high-average-power (>100 W). Although such laser sources offer a great potential for improving production scalability, they also present challenges relating to unwanted laser-induced heat accumulation effects which in turn pose a negative impact on the overall process efficiency/quality. Thus, effective new solutions are required to exploit such high laser output and enable its broader implementation at an industrial scale. In this regard, spatial (e.g. beam splitting) and temporal (e.g. burst pulsing) beam shaping have been widely explored. Herein, we study throughput upscaling by utilising fully a 120 W femtosecond laser in burst mode (25 ns intra-burst time). The effectiveness of MHz burst mode processing was assessed for both percussion drilling of thin metal foils and structuring of ceramics and compared with single-pulse mode processing. The influence of critical laser parameters in both processing regimes was analysed in terms of removal rate, ablation efficiency and resulting feature quality by evaluating the dimensional and morphological characteristics of the micro-machined features. Our preliminary results indicate the potential of MHz burst mode for significantly improving process efficiency while achieving superior feature/surface quality compared to single-pulse processing. A comparison between different burst mode regimes, i.e. MHz and GHz bursts, will also be discussed.