High-Power Ultrafast Laser Texturing: From Micro-Processing to Macroscale Applications

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Femtosecond lasers have seen a tremendous increase in average power over the past decade, with industrial lasers now reaching the kW level. At the same time, new applications are continuously emerging across various industrial sectors, including health, manufacturing, energy, and transport. Today, femtosecond laser processing is a key technology enabling large volume, high precision industrial manufacturing. The "agility" of these lasers combined with advanced beam engineering now available, enables flexible, reconfigurable production processes. High average power femtosecond lasers significantly boost productivity, and thus open access to new and large markets such as aeronautics, energy and mobility, which were previously out of reach.

However, making full use of the available average power without losing the high quality of ultrafast laser processing is not straightforward and requires advances in laser design and associated beam engineering. For instance, high laser repetition rates up to 10 MHz or temporal shaping of pulse trains with bursts of pulses, allow for specific process optimization with the use of beam deviation at very high speed if suited pulses synchronisation is possible.

Collaborative projects such as MULTIFLEX (https://multiflex-project.eu/) are already paving the way by developing high-power femtosecond platforms capable of handling large surfaces with unparalleled precision and throughput. This next-generation femtosecond laser technology is poised to move beyond traditional micro-machining, becoming integral to "macro" industrial production, where efficiency and quality improvements are critical to large-scale manufacturing.