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HIGH-RATE USP SURFACE STRUCTURING IN ROLL-TO-ROLL PROCESSING

Task

Ultrashort pulsed laser radiation (USP) enables the industry to precisely generate microstructures on a wide range of materials, but it cannot be transferred to large-scale industrial production processes since its productivity is still too low. Multi-beam systems are a key technology to fully exploit the potential of high-power USP laser sources. Beam splitting via diffractive optical elements can parallelize USP processes, increase the total power that can be converted, and significantly boost productivity.

Method

To increase productivity, Fraunhofer ILT has developed a continuous USP multi-beam machining process with a 160 W USP laser source in a roll-to-roll system. The optical multi-beam module splits the laser beam into a total of 4 x 6 partial beams, with each of the 6 partial beam bundles simultaneously guided over the strip by a total of 4 galvo-scanner systems. Sensors are used for process and quality monitoring, which, for example, precisely record the strip position and can validate the structures produced inline. By combining continuous feed of the strip material and a system technology for parallelized, large-area processing, the institute has developed a system that can utilize greater laser power and, thus, significantly increase the productivity of USP laser material processing.

1 Structuring module and roll-to-roll plant.

2 Structured electrode tape material.

Results

Thanks to the multi-beam structuring module, the number of structures introduced per unit of time and area can be increased by one order of magnitude compared to the conventional single-beam process. This USP multi-beam module makes it possible to process to 1.2 million structures per minute. In addition, a continuous USP structuring process has been developed, which is regulated with inline sensor technology.

Applications

Applications can be found in any roll-to-roll manufacturing process (e.g. battery, hydrogen, photovoltaics). The institute's current work focuses on the production of battery electrodes for lithium-ion batteries with liquid electrolytes. Its goal is to increase the power density and lifetime of the cells by introducing periodic hole structures into the battery electrodes.

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