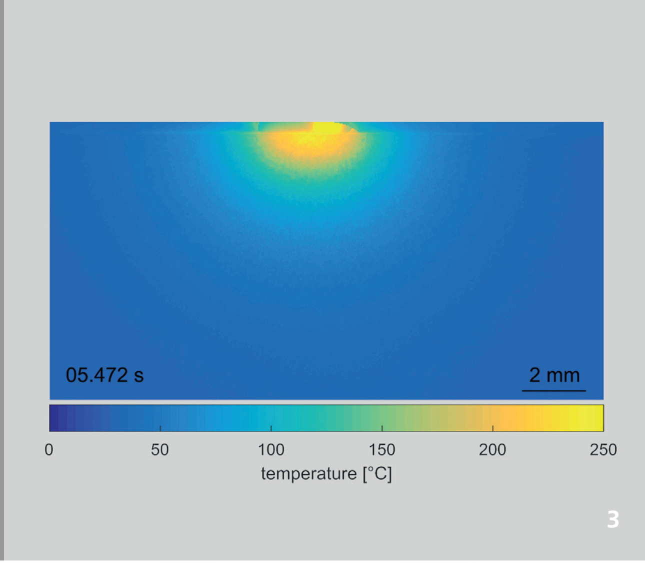

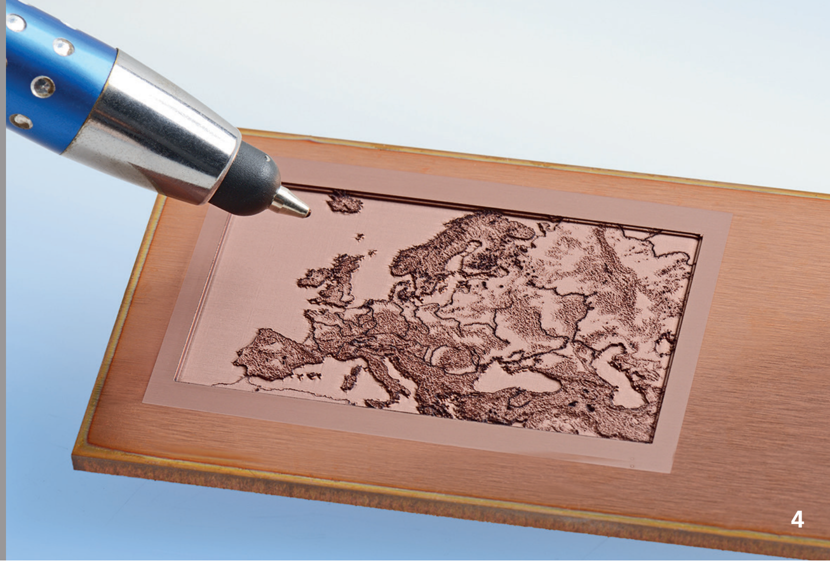

THERMOGRAPHY TO OPTIMIZE THE HEAT INPUT DURING ULTRASHORT PULSE PROCESSING

Task

For the productivity of ultra-short pulse (USP) processes to increase, the power needs to be scaled. When this is done, however, process quality suffers owing to thermal effects – such as molten material, changes in material structure or distortion – despite the short pulse durations. The heat input limits the applicable power, especially when processing thermally sensitive materials such as plastics or thin metal foils.

Method

By using thermography during the machining processes and comparing it with mathematical models, the Chair for Laser Technology at RWTH Aachen University has been able to gain a detailed understanding of heat input for the processes under investigation. The heat distribution on the surface of the machined materials is recorded over the process time for different process parameters. The temperature development over time is then evaluated and compared with a simulation based on a physical residual heat model.

Results

As residual heat accumulates during USP processes, very complex interrelationships between the process parameters prevail, interrelationships that cannot be fully understood with reduced physical models. For example, temperatures can differ by a factor of three when the repetition rate is varied at constant average power. Furthermore, during the process, surface effects can cause changes that are not covered by the static models for heat input. When these effects are understood, the processes can be optimized with respect to minimized heat input at maximum productivity.

Applications

The understanding acquired here can help to implement high average power for structuring metallic workpieces as well as processing thermally sensitive materials, e.g. from the packaging industry (plastics) and filter technology (metal foils).

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3 False color image of the temperature distribution during USP processing of stainless steel.

4 Copper structure produced by an USP process at 300 W average power.