STRUCTURING BY LASER REMELTING

Task

Components with structured surfaces are taken for granted in many segments nowadays. Injection molding tools made out of metal are often used to structure the surfaces, while photochemical etching is a standard technique for structuring the tools themselves. But this technique is time-consuming and costly since the bulk of the process is still carried out by hand. Laser ablation is also an established technique for structuring metallic surfaces. Both techniques produce rough surfaces. In areas where hygiene is an issue, these techniques cannot be used since the components machined in this way cannot be cleaned adequately. Low processing rates also constitute another frequent shortcoming.

Method

As part of the FluidStruc project funded by the Volkswagen Foundation, an innovative technique for structuring metallic surfaces is being developed that involves remelting a thin (~100 μm) surface layer using cw laser radiation. The laser beam is moved over the workpiece and the resulting heat input melts the metal surface locally. At the same time, the laser output power is modulated at frequencies between 10 Hz to 100 Hz in order to constantly change the size of the melt pool. This modulation of the size of the melt pool causes the material to be redistributed, creating mountains and valleys. This leaves half of the resulting structure lying above its initial level and the other half below it. The surface layer solidifies directly from the molten material, producing uniformly low roughness in addition to the structuring and giving the structured surface a polished finish at the same time. Complex location-dependent laser power signals are being investigated to extend the range of surface structures that can be created.

Result and Applications

Numerous innovative structures are being created on tool inserts made out of 1.2343 (Fig. 2) using adapted laser output modulation in order to demonstrate this technique. These surfaces feature a low micro-roughness and are molded reliably in plastic using the structured tool insert (Fig. 1). After eight successive machining steps, the height of the structures is approx. 60 μm at a structural wavelength of one millimeter. The processing time for the structures is currently approx. 2 min/cm². One area of application for these kinds of structures is in the hygiene segment, where a suitable look and feel of the structured surface are as important as a good cleanability. These structures can also be used in all areas which employ innovative visual and haptic design elements. The good moldability of the structures in plastic, in particular, opens up a wide range of applications.

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1 Component molded in plastic with different fingerprint-sized structures.
2 Tool insert made out of 1.2343 with various innovative fingerprint-sized structures.