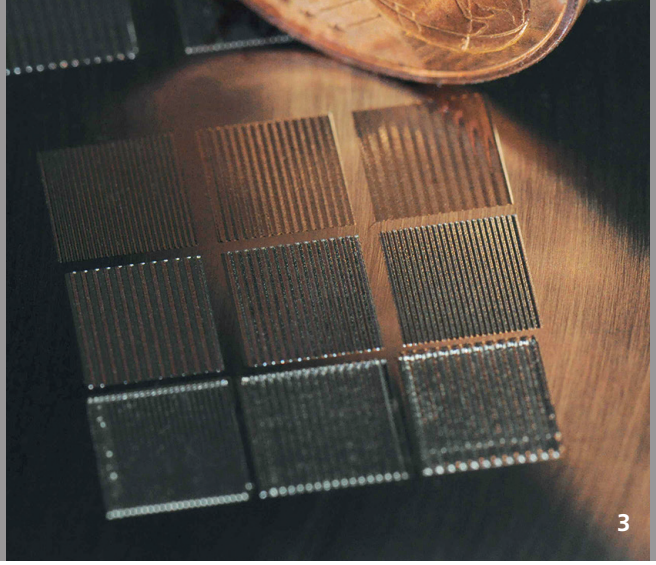

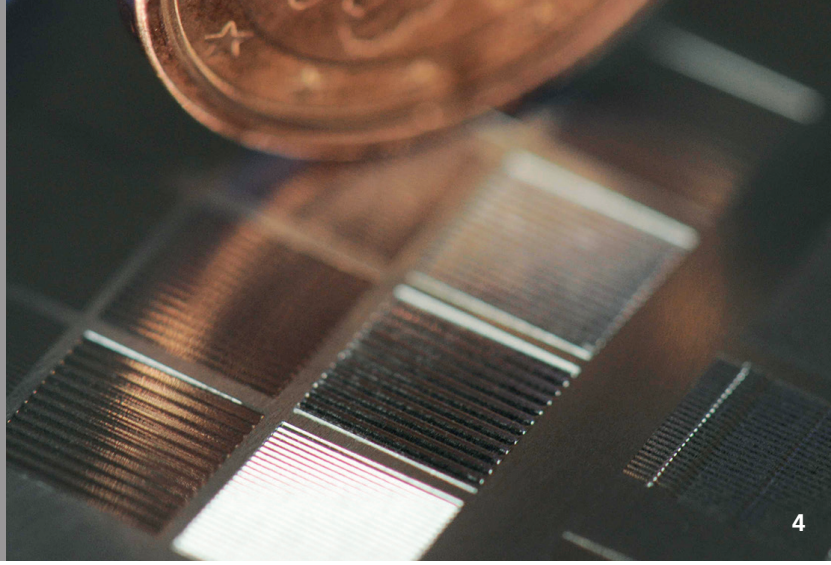

FAST LASER REMELT STRUCTURING (LUST) OF SMALL STRUCTURES OUT OF TI6AL4V

Task

Nowadays, one cannot imagine components without structured surfaces in many industrial sectors. The titanium alloy Ti6Al4V is widely used in many industries, starting with engine components for the aerospace industry, through implants in medical technology all the way to functional and design surfaces for the jewelry industry. However, the structuring methods currently used on this material (e.g. etching, laser ablation, etc.) are often time-consuming and/or cost-intensive and are based on a structuring by material ablation. Both methods produce rough surfaces which can only be used to a limited extent, for example, in the hygienic or design sectors. Moreover, the low ablation rate is another shortcoming.

Process Principle

Owing to these deficiencies in conventional processes, a novel process has been developed, laser remelt structuring (LUST). Here, a laser beam melts the metal surface locally by heat input. At the same time the laser power is modulated with frequencies between 10 Hz and 10 kHz, which results in a continuous change in the melt pool size so that the material is redistributed without ablation. In this way, the process generates mountains and valleys that lie half above and half below their initial level. The edge layer solidifies directly from the melt so that the surface is simultaneously polished as well as structured. As part of the »WaveShape« project sponsored by the VW Foundation, systematic experimental investigations have been conducted with laser beam diameters of less than 50 µm and scanning speeds of up to 500 mm/s for Ti6Al4V.

Results and Applications

The investigations confirm that a wide range of aperiodic and periodic structures can be generated on Ti6Al4V, which additionally have a small micro roughness (Ra < 0.1 µm). Using single track tests with a small laser beam diameter (50 µm) and a high processing speed (500 mm/s), Fraunhofer ILT has produced structures with a wavelength of 200 µm and a height of approximately +/- 90 µm for the first time (Fig. 3 and 4). This corresponds to a height-to-length ratio of almost one. Furthermore, the investigations show that the efficiency of the process, e.g. the achievable structure height per time, becomes even greater for larger scanning speeds if the laser power can be correspondingly adapted to the scanning speed. At present, an area rate of approx. 10 min/cm^2 has been achieved for these structures with a maximum laser power of 40 W and a scanning speed of 500 mm/s. Applications for such structures can be found, for example, in all areas in which novel functional (flow, light scattering) and design elements (optics, haptics) are desired.

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3 Demonstration sample with selected wave structures.
4 Sample for process development of wave structures.