High rate laser polishing using a polygon scanner

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The visual appearance and functional properties of a product are significantly influenced by its surface roughness. Surface treatment is therefore a common final step in industrial production. Despite technological advances, polishing is still typically performed manually, resulting in a time-consuming process. In recent years, laser polishing has emerged as an alternative process, but with still low area rates. Increasing the area rate of laser polishing has therefore been investigated.

In this study, a ns-boost laser with an average power of 3 kW and a power of 6 kW in boost mode was combined with ultrafast beam deflection using a polygon scanner. The laser beam source had a square top-hat intensity distribution in the imaging plane. The influence of processing parameters such as the pulse energy, repetition rate, scan speed and track distance on the resulting surface roughness and morphology of stainless steel 1.4301 was investigated. The aim was to determine the ideal process window for achieving minimum roughness values with high surface rates at the same time.

A high-quality surface was achieved with optimal processing parameters. The initial surface roughness of Sa = 0.275 µm was reduced to a minimum of Sa = 0.096 µm, a 65% reduction in initial surface roughness. Simultaneously, the surface gloss was increased from 125 GU to 400 GU, resulting in a 220% increase in gloss value. This transformation allowed the previously matt surface to become reflective, as shown in Figure 1, thereby enhancing the appearance of the material. The combination of the laser's boost mode with the polygon scanner allowed the full average laser power to be used for the polishing process. Furthermore, the square top-hat intensity distribution enables higher area rates by significantly reducing the line overlap compared to Gaussian intensity distribution. As a result, a real area rate of up to 156 cm^2/s could be achieved. The processing time was only 1.1 min/m^2, achieving industrial relevant process times for laser beam polishing.

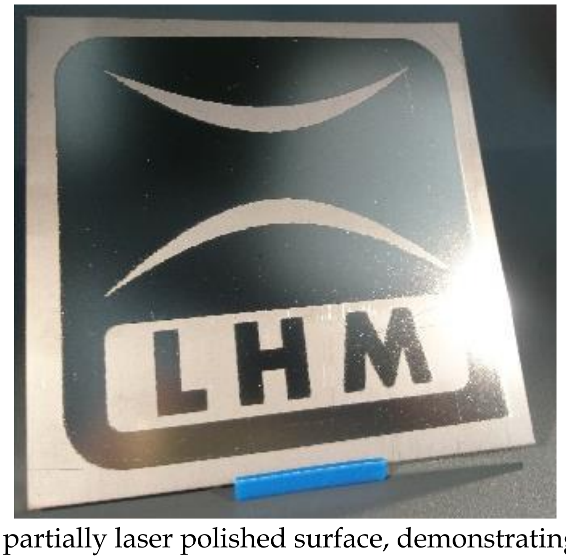

Figure 1: photograph of a partially laser polished surface, demonstrating the increased reflectivity of the polished area in comparison to the initial matte surface.