MEASUREMENT WITH LIGHT – MULTI-SPECTRAL PROFILOMETRY

THE TASK

Structuring of technical surfaces by means of laser systems is crucial for industry. The equipment for the precise manufacturing of micro and submicrostructures for surface functionalization and the generation of falsification-protected features is extremely complicated. New and task-specific measurement techniques must be developed to fulfill these requirements.

In laser surface structuring, it is very important to inspect material ablation in the running process. Ablation of material changes during processing as a function of the material properties of each surface and the machine parameters. Ablation of single microcoatings also changes the substrate material locally. These alterations in the material make it nearly impossible to calculate the ablation level for deeper layers in advance, and a special measurement technique is needed. Ablation volume quality and measuring rate are essential criteria for suitability for industrial use.

An industry-proof technique for material ablation measurement in laser micro structuring was developed at the IWS application center AZOM, Zwickau. The project is focused on precise and quick recording of coating properties during the process to implement the technology in the production environment.

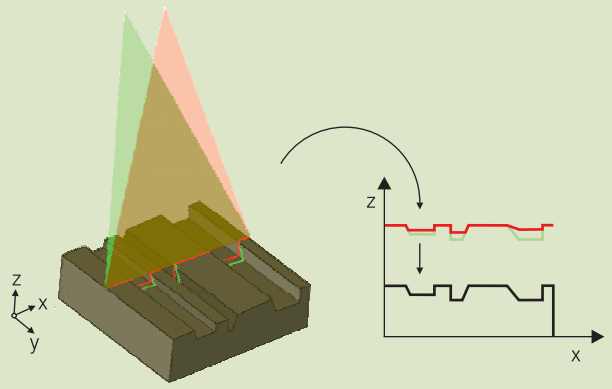
OUR SOLUTION

The task was solved by modifying and installing a measurement system based on light section technology (Fig. 1). Three different wavelengths are integrated in the setup. Lasers of 455 nm, 532 nm and 638 nm wavelength were focused linearly on the relevant sample region by cylinder lenses and separated into R(red), G(green) and B(blue) channels by camera.

The three wavelengths were radiated onto the sample at various angles to avoid shadows on three-dimensional surface structures, which would otherwise limit the potential range for height measurement. Using three different wavelengths also expands the range for dynamic detection in terms of the material properties.

The specific absorption of the various substrate materials relevant for laser materials processing means that conventional measurement systems are limited in their detection capability. Using several spectral ranges for surface analysis, one can

Principal multi-spectral measurement setup (two spectral ranges)



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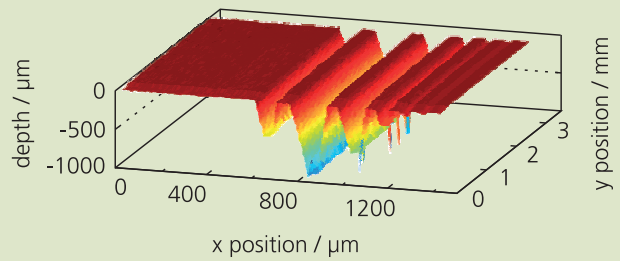
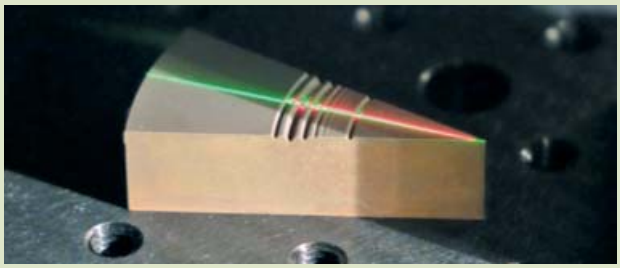
compensate for absorption effects by illumination with other spectral ranges that are more suitable here, thereby enhancing the measurement dynamics.

RESULTS

Extensive studies to refine optical components, such as measuring lasers and cameras, were performed in the project. The results showed that expensive special lasers are not necessary to achieve measurement accuracies in the low, two-digit µm range. A high-resolution camera, in combination with sophisticated software analysis, proved adequate to provide the required values. The AZOM project team contributed its expertise above all in analysis software engineering.

Representation of a calculated altitude profile (top) of a surveyed object (bottom)





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The use of precise filtering algorithms and the correct calibration of the measurement system made it possible to calculate high-resolution altitude profiles from data gained in test structure measurements (Fig. 3). The dynamics could be enhanced by analyzing all the three wavelength ranges.

The measurements and results were executed and verified both on height-setting normals (PTB TEN 900) and typical samples. The results gained in laboratory measurements are currently being implemented under real production conditions for an industrial partner. Therefore, the measurement setup was miniaturized and customized for laser materials processing equipment.

The use of this technology in other ranges of application, such as the packaging industry, extrusion of profiles, and in the textile industry, is being prepared.

2 Adjustment of the measurement setup

CONTACT

Dipl.-Ing. (FH) Christopher Taudt
☎ *+49 375 536-1972*
✉ *christopher.taudt@iws.fraunhofer.de*