Application notes

Leibniz Institute of Surface Modification

Large-area micro and nano-texturing of plane and cylindrical surfaces with high repetition ultra-short laser pulses

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The production of advanced packaging designs as well as specialized molding applications e.g. for printed electronic devise is a extremely fast growing market. In order to fulfill the demand of cost efficient mass production the usage of printing and embossing rolls is a standard technology. Therefore the fast and flexible engraving of rotating cylinder is a key element in modern industrial printing and moulding. The usage of laser processing techniques for the engraving process is widely used because of it unique processing characteristic in terms of flexibility and processing speed. However, limiting factors are the necessary post treatment of the laser engraved cylinders in order to fulfil the quality standards and limited resolution of the laser engraved structures.

Laser engraving with ultra-short laser pulse have shown excellent results in numerous application and contain the potential to reduce the necessary post processes and increase the resolution drastically due to the inherent cold laser ablation process. Laser processing with ultra-short laser pulses gives the possibility for texturing of surfaces with sub-micrometer size structures by using self organising physically effect. Due to the sub-micrometer size of this structures these structures are optical active and give the product designers an unexplored option in terms of appearance and functionality. In order to increase the productivity of laser material processing the laser pulse repetition rate as well as the average laser power have been increased to several MHz and several 100 W average, respectively. These lasers provide new opportunities to process materials with high yield and efficiency, but their deployment in production on a large scale is blocked by the lack of adequately scaled scanning systems. Higher scan speeds enable ultra-short pulsed laser sources and will reduce product manufacturing cost.

In this present application note the results laser engraving and texturing of copper and chromium sleeves are presented. As laser source a Ekspla Atlantic 60 picosecond laser (60 W, 13 ps, 1 MHz) was used. As fast scanning system a NEXT Scan Technologies polygon scanner LSE was used. The key to Next Scan Technology is its proprietary F-Ω™ strip-mirror optics, combining the telecentricity of F-Theta optics (focal length of 190 mm) with scan width of 170 mm and proprietary controls SuperSync™ for laser synchronization. The polygon scanner provide 100 to 400 line scans per second with a substrate scan speed between 25 to 100 m/s.

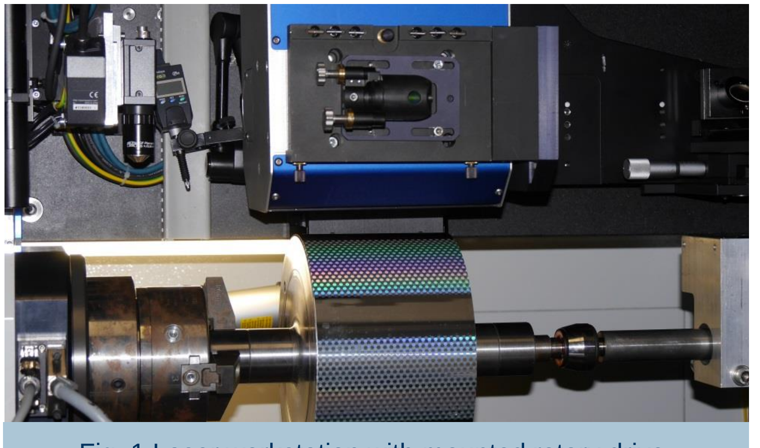

Fig. 1.Laser workstation with mounted rotary drive

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The scanner system was combined with a fast rotation axes as it can be seen in figure 1. The rotation axe holds a cylinder on which different copper or chromium sleeves could be spanned.

In order to show the flexibility of the laser-scanner-rotation system different test structures were engraved in copper or chromium sleeves.

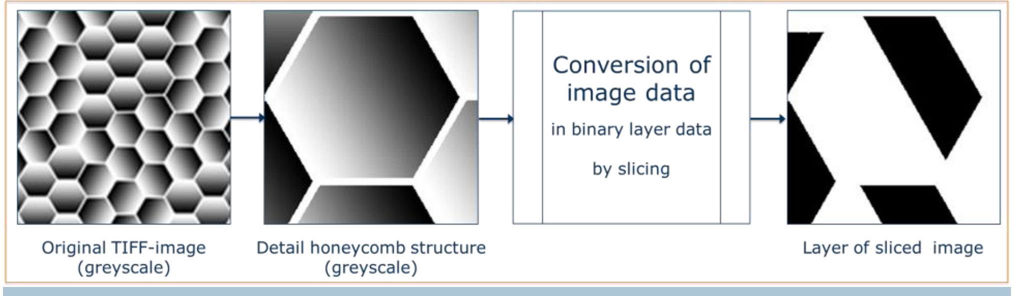

Fig. 2. Workflow of data preparation for the scanner system

The pre data preparation work flow is shown in figure 2. The original greyscale TIFF image of the test structures were converted in binary layer data by slicing. A bitmap image of those layers are streamed to the scanner system. Figure 3 shows a engraved test structure in a copper sleeve. The laser processed areas have a high quality and no very limited post processing of the structured surface are required to fulfil the required quality demands of the most printing and molding applications.
By using specific laser-scanner processing parameter the generation of self organized structures can be achieved. The size of these structures can be compared with the length of the used laser light with 1064nm causing the visual rainbow effect of the laser textured areas. By adjusting the polarization direction of the laser beam the orientation of the structure can be changed which gives a great freedom to generate a variety of visual and functional effects. In figure 4 a magnified view of a chromium sleeve is shown in which an arrangement of honeycomb like areas were generated. Due to the changing of the polarization direction of the laser beam the three different visual states (rainbow, grey, black) could be achieved.

Fig. 3. Laser-engraved structure, copper sleeve

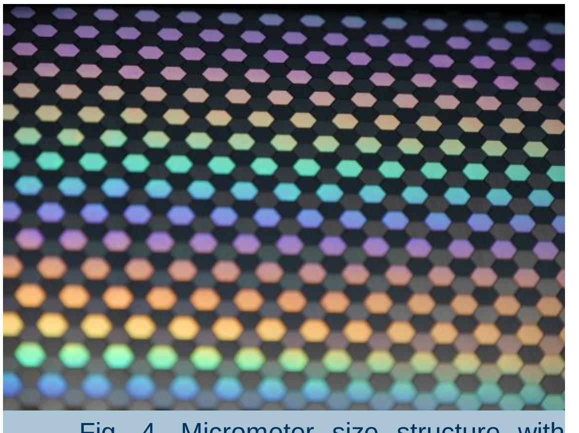

Fig. 4. Micrometer size structure with additional optical active nanometer size structures, chromium sleeve

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Conclusion

The combination of the high speed polygon scanner system form Next Scan Technology and the Ekspla Atlantic picosecond laser providing high power with high repetition rate has been tested for application suitability. It has been shown that the production of 3D micro structures is possible with high precision and quality. It has been found that this System is particularly suitable for the production of optic active, self organized micro structures. Not only in the case of quality but also in terms of performance and cost effectiveness.

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