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Contact System of Solid State Surface Mapping

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Abstract: The advantages of contact solid state surface mapping are reminded in this paper. Some possibilities are demonstrated by several examples. These examples include measuring of laser beam treated silicon surface and mapping of laser cuts in metal sheets.

Keywords: Contact sensing, contact profilometer, 3D imaging of solid surfaces

1. Introduction

The measurement and evaluation of the properties of components are currently becoming increasingly important. The requirements on dimensional accuracy of products and their surface properties are still rising, as these properties are often linked to reliability and durability. This requires highly reliable and accurate equipments which are able to give the desired results repeatedly and with high resolution [1]. Basically it is possible to use two methods for mapping of solid surfaces – contact or non-contact. Non-contact methods have many advantages over traditional contact methods. In particular, there is no danger to damage the surface, the measurement is fast and allows us to control soft and flexible surfaces. Usually more data are obtained in non-contact measurement. And finally non-contact optical devices aren't as prone to wear and damage as contact ones.

In spite of it, using of contact apparatuses has still its significant place and reason. Let's take only one example of all. The evaluation of light reflected from a solid surface and the evaluation of data acquired by contact measuring on the same surface can be significantly different. Correlation between the results of contact and non-contact measuring is not always possible. In addition, standards often define the properties of solid surfaces just on the basis of the values measured by contact profilometers. Furthermore, modern contact profilometers reach very fine resolution (often in the order of nm), which is quite sufficient for most measurements.

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Other advantages of contact devices include minimal specific requirements for the properties of any solid surfaces. And finally, the measurable area of contact devices is usually much larger than the area that can be recorded by most of the optical non-contact devices. The biggest disadvantage of the contact apparatus seams to be a long time of 3D pictures recording. 3D image is acquired when stylus scans a surface in parallel lines with constant distance. In case of very small distance between the lines, the measuring can be really very time-consuming. On the other hand a very fine step is not always necessary. Its appropriate choise can substantially reduce the measuring time.

2. Several examples of surface display

Spatial analysis of the surface opens up new possibilities of structures classification that were impossible in 2D display. Detailed 3D surface description seems to be beneficial especially when considering its functional properties such as wear, friction, lubrication, fatigue properties, sealing contact areas or suitability of the surface for painting. Used computer program is capable to provide 3D image surface in several ways, and the selected images can be rotated a scaled to optimize the view [2]. It is also able to choose any detail from the image and ascertain its volume, dimension, area, perimeter and other properties.

The first example shows surface of silicon plates which were cut with a wire sawing machine. These plain plates were then scribed with pulsed laser and the changes of the surface were then mapped with Form Talysurf Series 2 device. Some of possible images are shown in Fig. 1 and 2. There are chosen black and white pictures only in this paper. Both pictures show the same area of pulsed laser trace crossing. 3D image is very graphic, the same area in 2D photosimulated projection shows this situation also very well.

Fig. 3 and 4 show some possibilities of imaging of laser welds which were made in our department. There was a need to control particular dimensions and bulk properties of welds created under different conditions and 3D display has proven to be very useful for these tests.

The last example displays the area of laser beam cut in thick steel sheet. It is well-known that the cutting area is not homogenous. Similar problem is discussed in [3] where the area of aluminum cut made by abrasive waterjet cutting is described. Both cases point out that the area of cut relief shows significant differences depending on the distance of the reference point from the edge of the sheet. Presented 3D imaging (Fig. 5 and Fig. 6) illustrates very clearly how the monitored area looks like.

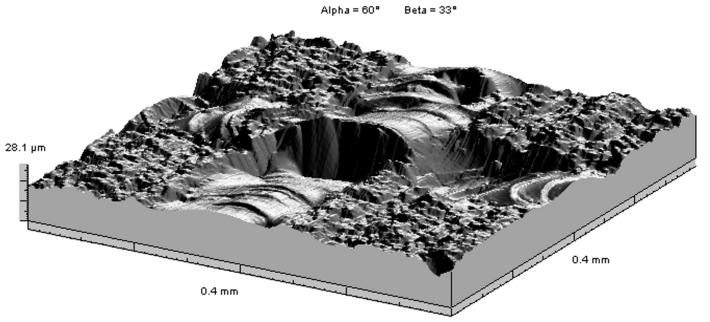

Fig. 1. 3D display of silicon surface after laser beam scribing. This type of imaging provides very good vision about probe surface.

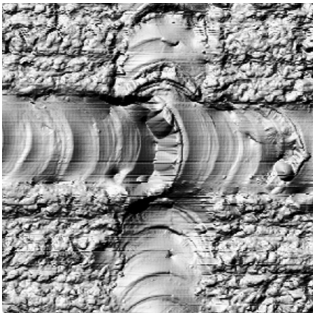

Fig. 2. 2D photosimulation image of the same surface as in Fig.1.The dimensions of this area are 0.4x0.4 mm.

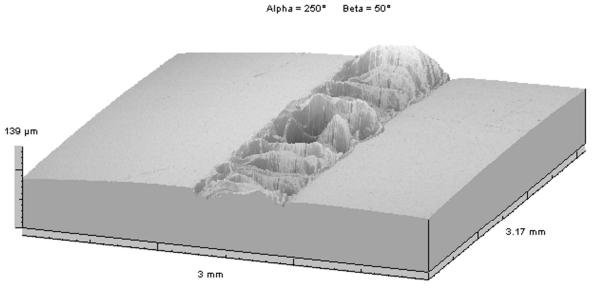

Fig. 3. The image of steel weld made by pulsed laser.

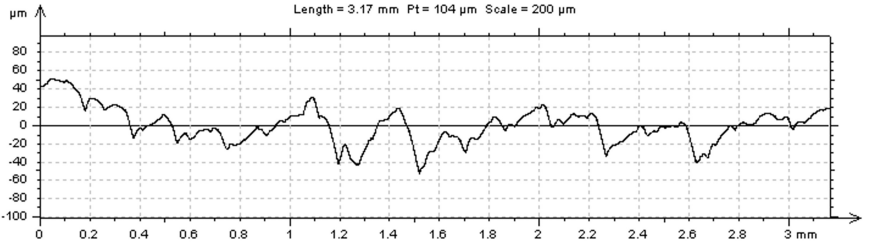

Fig. 4. Selected profile of the weld presented in Fig. 3. The line is maintained over the entire viewing area.

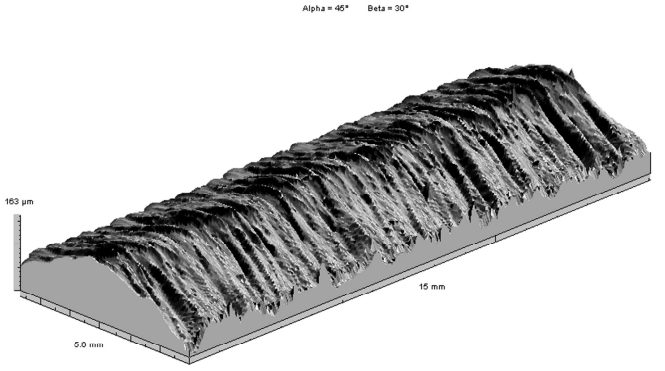

Fig. 5. Continuous axonometric type of image of the cutting area made by high power continual laser.

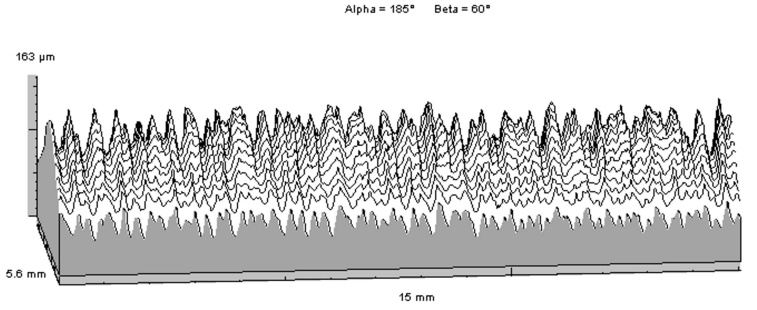

Fig. 6. Black and white axonometric map area of a cut. There is significantly magnified vertical dimension in this image for overstricking of differencies on surface.

3. Conclusion

The aim of this report is to point up merits of contact profilometer and to proof that this type of instrument has still its important place in the mapping of solid surfaces despite of vehement entry of non-contact devices. It is demonstrated in several pictures and examples.

Acknowledgements

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References

[1] Baker L.R., *Metrics for High-Quality Specular Surfaces* (SPIE, Bellingham, Washington, USA, 2004). ISBN 0-8194-5576-8.

[2] Taylor-Hobson, *Exploring Surface Texture, a fundamental guide to the measurement of surface finish* (Taylor Hobson Limited, Leicester, England, 2003).

[3] Hloch S. and Valíček J., "Štatistické hodnotenie kvality povrchu hliníka pro delení abrazívnym vodným prúdom," *Jemná mechanika a optika*, **52**(2), pp. 51-54 (2007). ISSN 0447-6441.