Preprocessing of 3D Measurement Data of Microstructures with Large Lateral Dimensions

Martin Bretschneider, Dr.-Ing. Markus Kästner, Prof. Dr.-Ing. Eduard Reithmeier
Institute of Measurement and Control Engineering (IMR)
Leibniz Universität Hannover
Nienburger Straße 17, 30167 Hannover, Germany
E-mail: martin.bretschneider@imr.uni-hannover.de

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Abstract: Modifying the surface of highly loaded materials like cylinders of piston engines is a method of minimising wear and friction. There are already coatings like Alusil that are used in the cylinders of some combustion engines. The advantage of this coating are the very hard silicon particles, that are higher than the aluminium matrix, in which the silicon is embedded. Below the silicon particles there is volume to store oil improving the tribological performance. Another new method of modifying a surface for this purpose is a cutting process that can produce structures with a scale from a few micrometers to some millimetres. The lateral dimension of these microstructures can be up to a few millimetres, which complicates the measurement and data preprocessing. There are several methods of measuring the surface of these structures in order to get more properties as presented in [1].
In this paper several methods of measurement data preprocessing are presented, which are necessary before the properties of the microstructures can be evaluated.
A method to stitch a single microstructure using several high resolution measurements with an areal profilometer like a white light interferometer is shown. The principle is based on properties of the structure and does not depend on the information of the relative shift of each measurement.
Microstructures can be integrated within a form like the inner surface of a piston cylinder. The form of this cylinder has to be removed from the measurements data, which can be seen in Figure 1. A common way of removing the form is a least square fit with an appropriate polynomial with a degree of two. But since the microstructures have such a large lateral dimension, the surface fit is strongly influenced by the microstructures that results in a inaccurate fit. The proposed method uses a segmentation step that recognises the microstructures even in the measurement data including the form. Then the microstructures are removed from the surface and the fit is applied to this surface. Afterwards the fitted surface is removed from the surface with the microstructures. The result of this robust method is displayed in Figure 2.

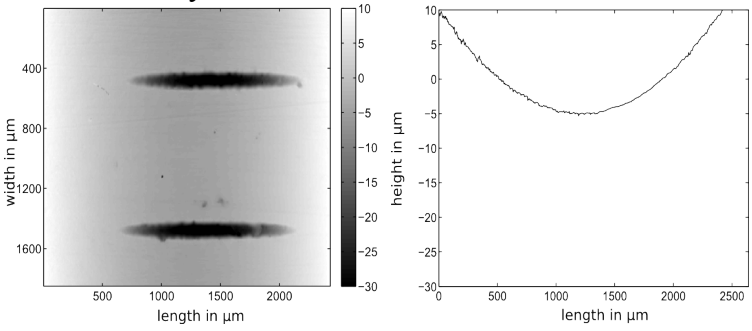

Figure 1: Data with the form of the piston cylinder

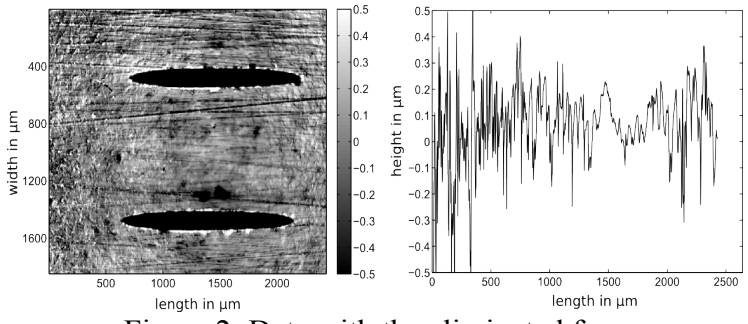

Figure 2: Data with the eliminated form

[1] Bretschneider, M.; Kästner, M.; Reithmeier, E. (2009): "Measurement and Characterisation of Microstructures made by Cutting Processes". Proceedings of the euspen 9th International Conference, San Sebastian, 02.-05. June 2009, Volume 2, pp. 223 – 226