## Surface microstructuring of journal bearings by ultrasonic vibration-assisted turning

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**Abstract**

Microstructuring of surfaces in lubricated sliding contacts can contribute to an improvement of their functional properties. However, the number of industrial applications is still limited due to a considerable higher manufacturing effort. This applies in particular to internal machining. The present paper describes a two-staged ultrasonic vibration-assisted turning process for an efficient production of micro dimples. In the first step, turning is carried out with a superimposition of ultrasonic vibration at the tool, perpendicular to the workpiece surface. The resulting microstructured surface is subsequently machined by precision turning without vibration assistance. Consequently, the peaks of the surface are removed resulting in a plateau-shaped surface with micro dimples.

The experiments focus on dry longitudinal internal turning of journal bearings manufactured from the bronze alloy CuSn7Pb15 with an inner diameter of 30 mm. The machining is conducted on a precision-lathe SPINNER PD32A with an integrated ultrasonic vibration system. A bending oscillator is used to convert the longitudinal vibration of the ultrasonic transducer into a transverse vibration. The working frequency is 24 kHz. As cutting material CVD-diamond is applied. The selection of the tool geometry and the cutting parameters is described exemplarily using two different variants of micro dimples with diameters of 60 µm and 100 µm, a depth of 7 µm and a structure density of 20 %. This is achieved using a MATLAB based simulation model that allows the prediction of the kinematic surface roughness. The three-dimensional characterisation of the surface topography is based on tactile measurements.

The results of the machining tests agree well with the simulation. The micro dimples are burr-free and almost circular. In the feed direction, a slight deviation from the circular shape can be determined. A slight asymmetry can also be seen within the profile in the cutting direction. The slope of the dimple flanks facing the clearance face is slightly flatter compared to the dimple flanks facing the rake face. This is mainly attributed to changing effective rake and clearance angles because of the oscillating movement of the tool. This study clearly highlights the potential of the machining process for an industrial implementation.

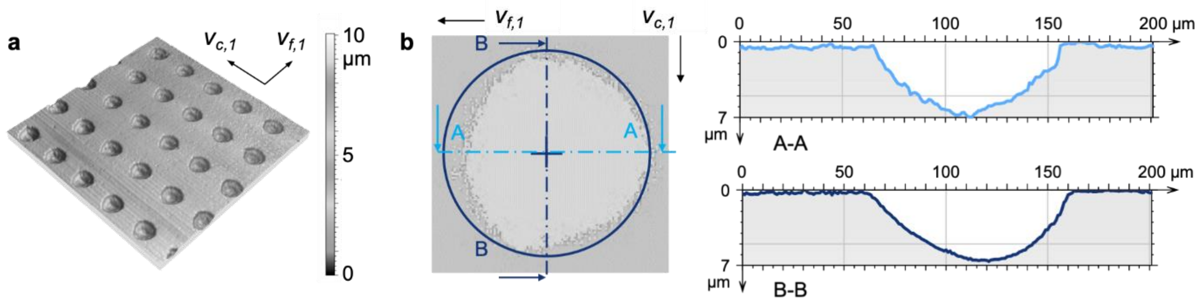


Figure 1: Microstructured surface with micro dimples with a diameter of approx. 100 µm. a, Surface detail (1 x 1) $mm^2$. b, Top view of a single dimple and profiles in feed and cutting direction. The process parameters refer to the first process step.