DETERMINATION OF THE MINIMUM QUANTITY OF LUBRICANT FOR SHEET METAL FORMING

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ABSTRACT

Component quality and process safety in sheet metal forming are decisively influenced by tribological fringe conditions. Besides sheet material and tool material, the type and quantity of lubricant applied to the sheet are of major importance. In cases of doubt, excessive quantities of lubricant are frequently used. Both for economic and ecological reasons, a method is therefore needed which provides simple means for assessment of the optimum quantity of lubricant.

A focal point of the studies is the topography of the sheet material, as this may be anticipated to have a major impact on the lubricant quantity required. Since two-dimensional surface parameters can describe the sheet surface inadequately only, a corporate research project for development of 3D parameters adapted to sheet metal forming was started (1,2).

As is the case in two-dimensional measuring, also the values of 3D indexes are decisively influenced by filtering. Sheet materials have different waviness depending on the manufacturing processes. For assessment of the amount of lubricant, waviness must be filtered out so far as to make the measuring area correspond to the material surface in tribological contact. The filters used in 2D-metrology have the disadvantage of being oriented at the mean profile, but not at the tribological contact surface. Comparison of the filtering methods was made on the basis of the void volume which was defined to be 100 % for an artificial surface without waviness.

Fig. 1: Model surface with waviness

The void volume calculated for the surface including waviness is too high by 70 %.

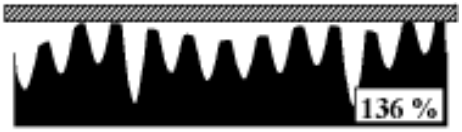

Fig. 2: Surface filtered with a rectangular filter

Fig. 3: Model surface filtered with a double filter

Both the rectangular filter and the double filter with striation suppression (DIN4776) just calculate part of the waviness out of the profile. In contrast with this, using the ball filter results in 103 % and thus approximately the actual void volume.

Fig. 4: Model surface filtered with a ball filter

In order to adapt the ball filter to the requirements of sheet metal forming, a modified ball filter was developed by PtU which permits a defined number of points to penetrate into the ball.

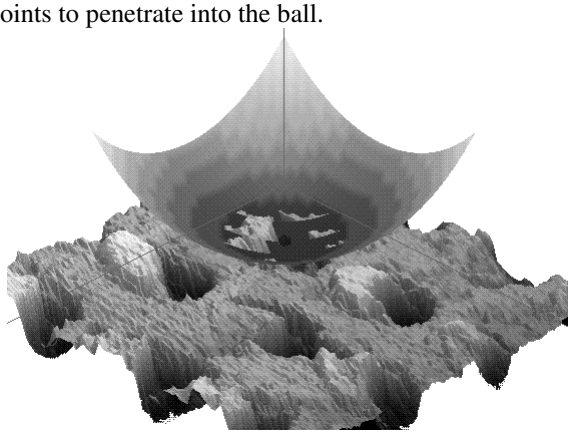

Fig. 5: Principle of the modified ball filter

Apart from suppressing isolated peaks, this permits to achieve that filtering is oriented at the elastically and plastically deformed contact surface.

In order to assess the influence of the filtering methods, a representative cross section of the sheet materials currently used by the automobile industry for producing car body parts were evaluated on the friction testing equipment. The results clearly show the advantage of the modified ball filter.

References

(1) Wagner, S., 1996, 3D-Beschreibung der Oberflächenstrukturen von Feinblechen, Dr.-Ing. Dissertation, Technical University Stuttgart, Germany

(2) Geiger, M., Engel, U., Pfestorf, M., 1997, New developments for the qualification of technical surfaces in forming processes, Annals of the CIRP, 46/1

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