Analysis of the active abrasive grains in the films abrasive finishing process

Analiza aktywności ziaren ściernych w procesie wygładzania foliami ściernymi

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In the paper the active of abrasive grains in the films abrasive finishing process was analyzed. The results of the simulation of surface smoothing process were presented. The subject matter of the analysis was a 3IDLF diamond abrasive film.
KEYWORDS: active abrasive grains, films abrasive finishing process

Regardless of the treating method, abrasive grains in the contact zone with the object, move tangentially to the work surface, and the recess into material is variable along the cutting path. Variability of depressions depends on many factors. The most important include:
- variation of the nominal depression, which depends on the kinematic characteristics of the method;
- surface irregularities in the machining zone;
- local susceptibility of the workpiece and abrasive grains [2, 3, 6];
- vibration of tools and abrasive grains;
- substantial local variation (at the impact zone of the grain) temperature rise - especially when working with very high speed, materials of low thermal conductivity - and variability of the properties of the material treated in micro-volume compared with the volumes of layers machined;
- macro- and micro discontinuity of chip formation and flow generation [4, 6–8].

Probability of contact of grains on the surface of the abrasive tool and workpiece material with a specific topography of the surface depends on the statistical features of the grain apex and coordinates of the machined surface [6, 9, 10, 12], thickness of the removed layer, kinematic characteristics of the process, and the tool's susceptibility.

Diagram for the probability analysis of contacting the tips of abrasive grains and workpiece heights is shown in fig. 1. The probability of contact between the blades and the workpiece decreases with the movement of further tool surface areas over the surface already treated by the preceding zones. The smaller the thickness of the removed layer, the lower the probability of contact with the workpiece grains.

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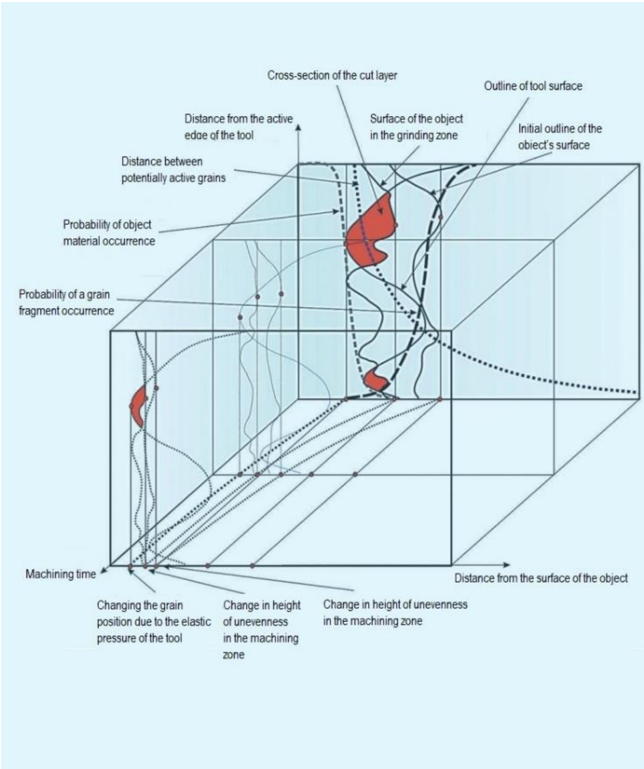

Fig. 1. Diagram for the analysis of possible grain contacts with the material of the object in the process of machining using susceptible abrasive tool

In the case of abrasive tools with a greater vulnerability (such as abrasives foils [13] or grinding wheels with susceptible binders), recesses in grains are reduced and the probability of contact less decrease with time of machining (fig. 2).

Methodology of research and analysis results

In order to carry out the analysis of the grains activity on the abrasive foil being in contact with processed surface, tests of the surface following the smoothing process using the Taylor Talbot Talysurf CCI 6000 measuring system were performed (fig. 3).

Then, the acquisition of the surface of a diamond abrasive film 3IDLF (grain size of 3 μm, fig. 4) was made using a confocal microscope LEXT OLS4000 Olympus.

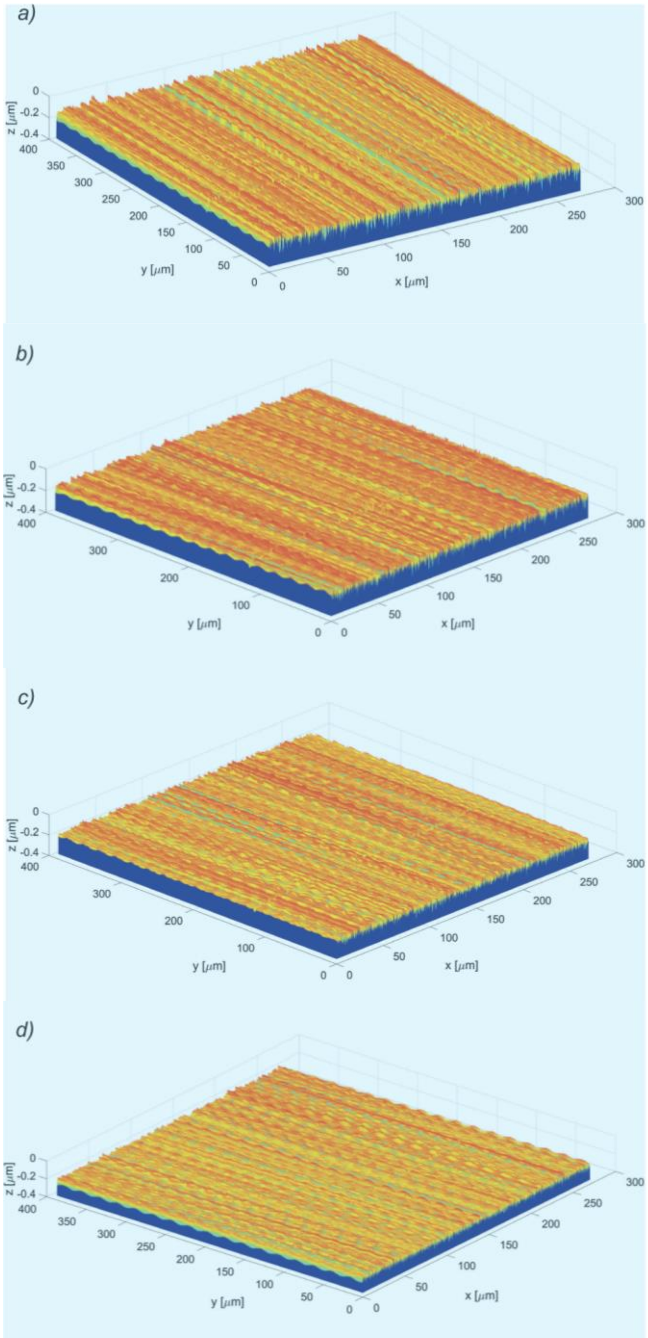

Fig. 2. Surface images in 4 phases of smoothing process using abrasive foil after a certain number of passes: *a*) 9, *b*) 19, *c*) 29, *d*) 39

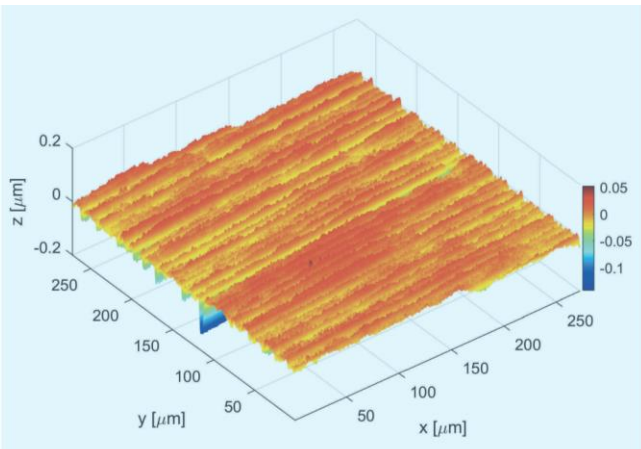

Fig. 3. Surface image of smoothed object using 3IDLF diamond abrasive film

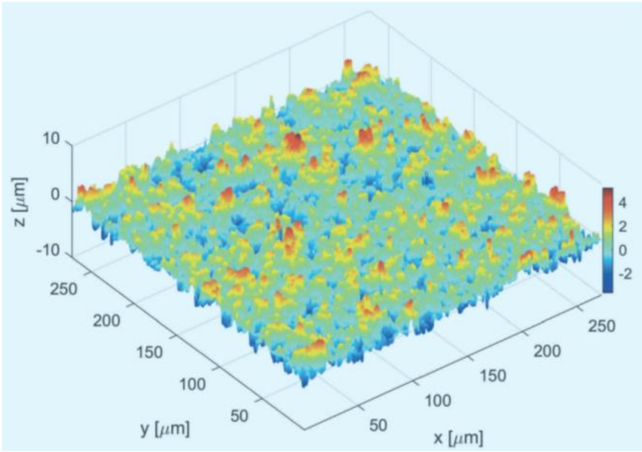

Fig. 4. Image of 3IDLF abrasive film surface

An analysis of the features of the contact surfaces of the object (fig. 3) and the surface of the foil (fig. 4). For this purpose, applications were developed in the MATLAB computational environment, which included procedures for determining the characteristics of the contact zones (fig. 5 and fig. 6) as a function of surface proximity. The proximity values were in the range of 10÷35% (*St*(surface) + *St*(foil), starting from the starting point, where the topmost point and the lowest point of the tool surface are at the same level, although in general they do not come in contact with each other.

At each level of proximity, following parameters were determined: number of contact fields per unit area, average contact area, and average distance between the contact areas. Values of the contact area parameters are given in fig. 5.

The next step in the analysis of abrasive grain for polishing using abrasive foil was simulation of this process. For this purpose, a complex system for abrasive foil smoothing simulation was applied, which was implemented in MATLAB [5]. The basis for the development of this system was a grinding wheel simulation system that was used to predict Ti alloys grinding parameters [1]. Its modification consisted in the development of new kinematic procedures for smoothing with abrasive films.

The following machining parameters were assumed: longitudinal speed of the workpiece v_{ft} = 0.5 m/s, number of transverse feeds i_{pp} = 40. During the simulation process, the maximum values of cutting sections h_{max} were recorded (fig. 7).

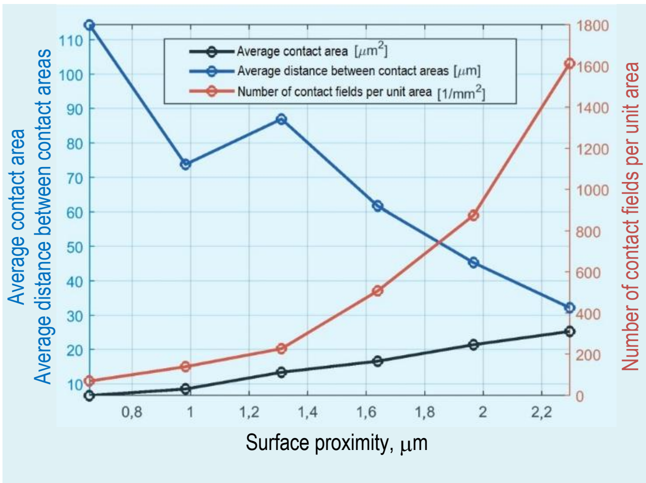

Fig. 5. Parameters of the contact areas; *St*(surface) = 0.119441 μm, *St*(film) = 6.3635 μm

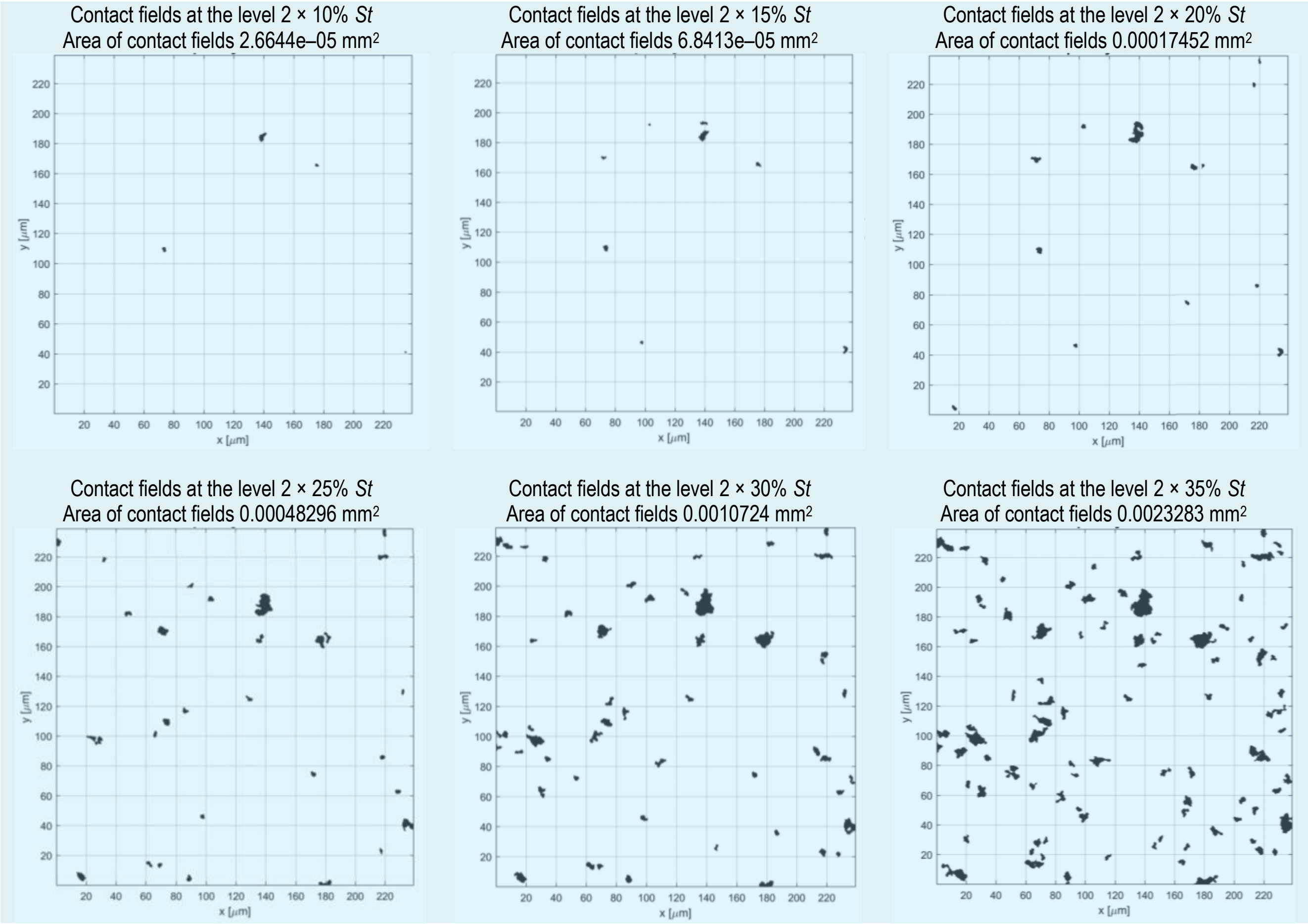

Fig. 6. Contact areas (top view) for different levels of abrasive film proximity to the surface from the lowest point of the film and the highest point of the workpiece

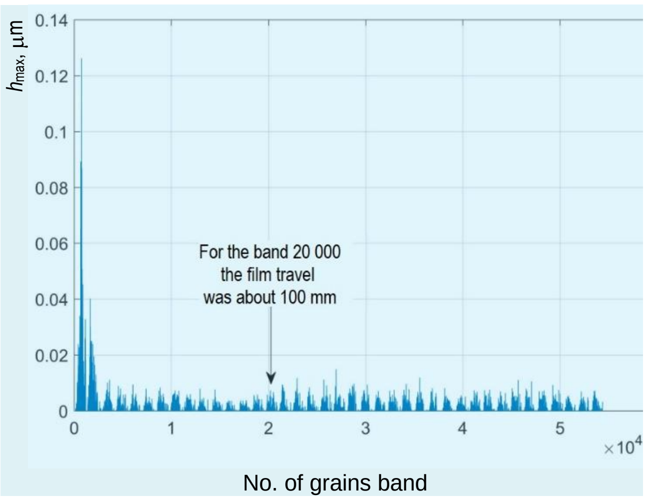

Fig. 7. Average value of the maximum section height of the cutting layer h_{max}

Based on this information, it was possible to determine the activity of grains in subsequent tool passages above the work surface.

Conclusions

Determining the impact of the abrasive film on the size and shape of the potential contact surfaces of the work surface with the surface of the tool is facilitated by the selection of the process parameters and features of the pressure rollers, and predicts the smoothing results and scheduling the duration of individual treatments in the sequential smoothing processes.

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