Analysis of the forms of wear and durability of the abrasive films

Analiza form zużycia i trwałości folii ściernych

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The paper analyzes the wear and durability of abrasive films designed for microsmoothing produced by electrostatic method. In order to carry out tool wear studies, a microgrinding process was performed using an abrasive film with a nominal grain size of 15 μm. The next step was the study, using scanning microscope. Crushed grains were observed on the surface of the foil, overflows, and extremely high temperatures in the treatment zone, above 1400°C, which resulted in the formation of spherical chips.

KEYWORDS: microfinishing, abrasive film, tool wear, spherical chips

The process of micro-smoothing of the surface with abrasive films ensures very smooth surfaces. Characteristic features of the process include single use of the tool and very long machining traces, which is the result of up to 1000 times the speed of the workpiece compared to the speed of displacement of the abrasive film [3, 4].

During production of IMFF micro-smoothing films, the process of deposition of abrasive (noble corrugated) on the surface of the carrier (polyester film) covered with the base binder layer is carried out by electrostatic method (fig. 1).

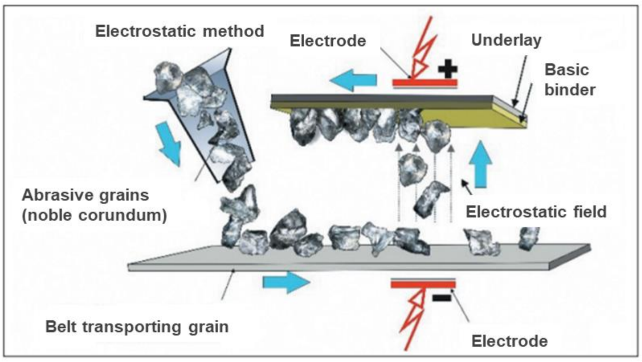

Fig. 1. Diagram of the production of micro-smoothing films by electrostatic method [6]

After hardening the base binder, an additional layer of binder is applied to the surface of the tool. binder to increase the durability of microfiltration film. The electrostatic method of depositing abrasive grains on the surface of the support provides such orientation of the cutting blades to obtain a preferred topography of the active surface of the tool (fig. 2). Due to the excellent abrasive properties of the micro abrasive films, they are used to prepare the surface for the subsequent micro-smoothing treatment with the use of super-smoothing films [6].

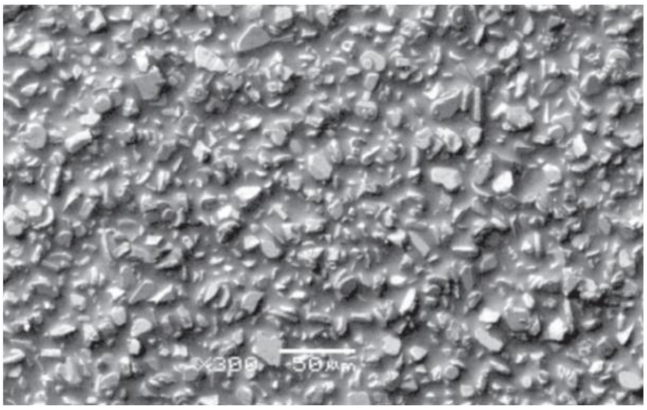

Fig. 2. SEM image of an IMFF abrasive film surface with a nominal grain size of 15 μm

Study of wear patterns of abrasive film

Abrasive film wear testing was performed after the micro-smoothing of elements made of 40H hardness 60 HRC steel. Studies of the abrasive smoothing process using the GW-1 micro-smoothing head were performed using a 50°ShA pressure roll. The workpiece load pressure was 50 N, the abrasive film speed 160 mm/min, and the peripheral speed of the workpiece was 40 m/min. The total time of the micro-smoothing process was 50 s.

After the micro-smoothing process, the abrasive film was purified from the treatment products and subjected to microscopic examination (fig. 3).

On the surface of the film after the micro-smoothing process, about 8% of the abrasive grains (fig. 4) were observed. The grafting phenomenon has a direct relationship with the electrostatic deposition method in the binder (the grain is generally embedded in the binder to about 2/3 of its height and can be crushed). Removed abrasive grains, remaining in the processing zone, can result in single, deep scratches, which significantly aggravates the smoothing results.

Grain offsets can have a positive effect on the efficiency of the removal of the treatment products from the treatment zone. In the process of micro-smoothing, the microstructures are in the processing zone in the spaces between the grains. The resulting space after crushing the beans increases the volume for storage of the micro-chips (fig. 5).

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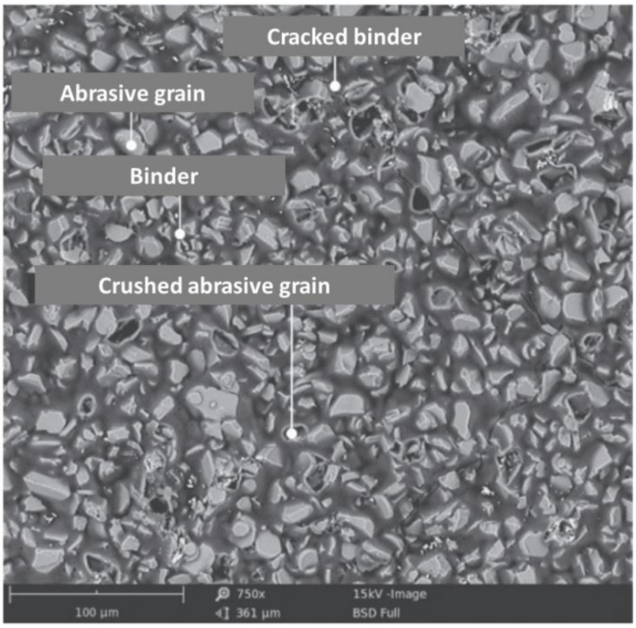

Fig. 3. SEM image of IMFF abrasive film surface with a nominal grain size of 15 µm after the micro-smoothing process

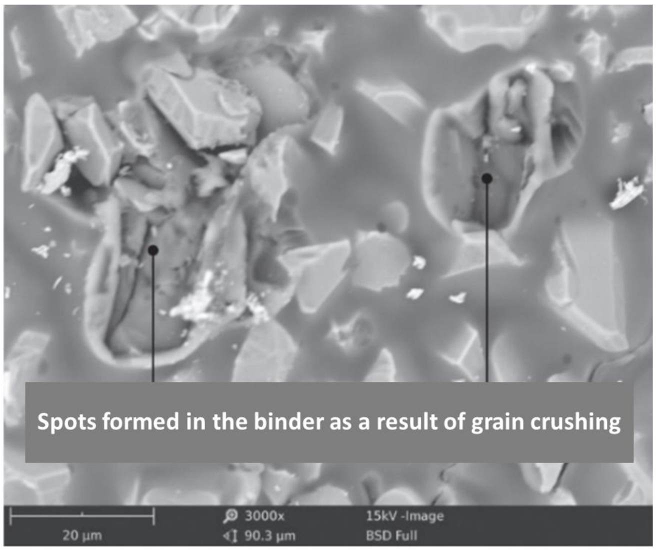

Fig. 4. SEM image of space created by crashing the abrasive grains on the surface of 15IMFF film after micro-smoothing process

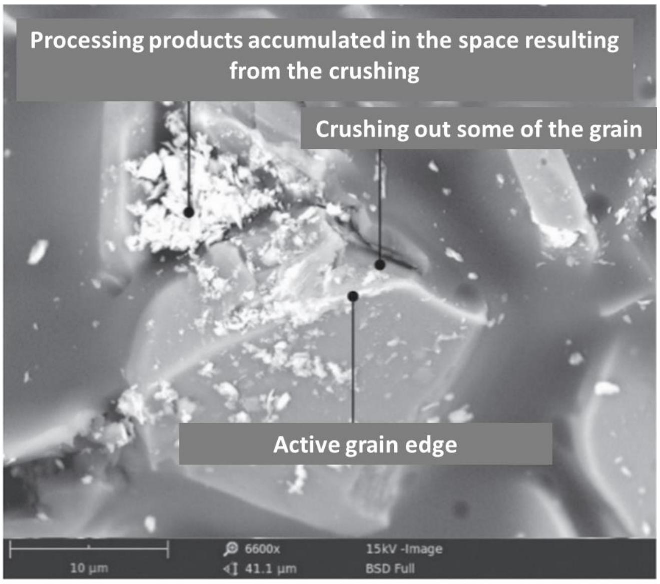

Fig. 5. SEM image of abrasive grain on the surface of the 15IMFF film after the micro-smoothing process

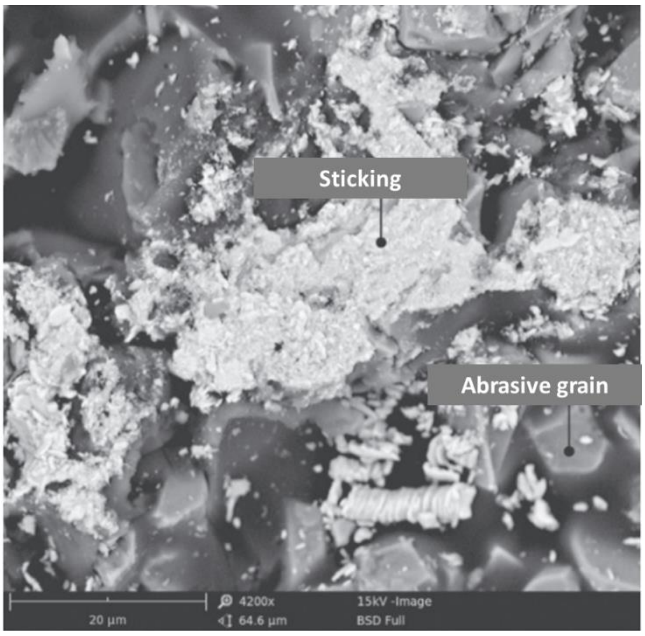

Fig. 6. SEM image of abrasive grain on the surface of the 15IMFF film after the micro-smoothing process

Too low speed of abrasive film can cause overheating (fig. 6). Bonding occurs as a result of the limited interstitial space required for the storage of microorganisms and the presence of locally high temperatures in the treatment zone.

After removal of the treatment products from the surface of the foil, and after their placement on the carbon strip, microscopic examination was carried out. The presence of long streaky microstructures (fig. 7 and fig. 9) is observed, which is the result of the discontinuity of chip formation along the long grain path.

In addition to micro-chips of stepped microstructures, the presence of crushed spherical grains was also observed. The presence of such chips is indicative of high temperature in the treatment zone, which is a disadvantage [1, 2, 5].

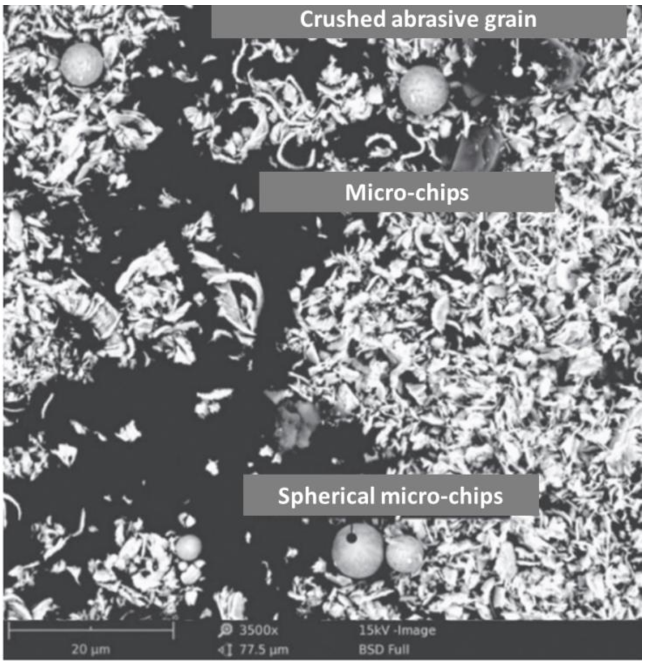

Fig. 7. SEM image of products from the process of micro-smoothing with abrasive film

In order to confirm that the resulting spherical microforms are processing products, their chemical composition was analyzed. This study was performed using a modern electronic scanning microscope from JEOL, equipped with an EDS (X-ray energy dispersion) analyzer.

The AB segment was analyzed (fig. 8). The high concentration of carbon at the beginning and at the end of the measuring section is due to the fact that carbon tape was used to prepare the microscope sample. The presence of oxygen and iron demonstrates that the melting of the workpiece and its rapid solidification during the micro-smoothing led to the formation of spherical chips.

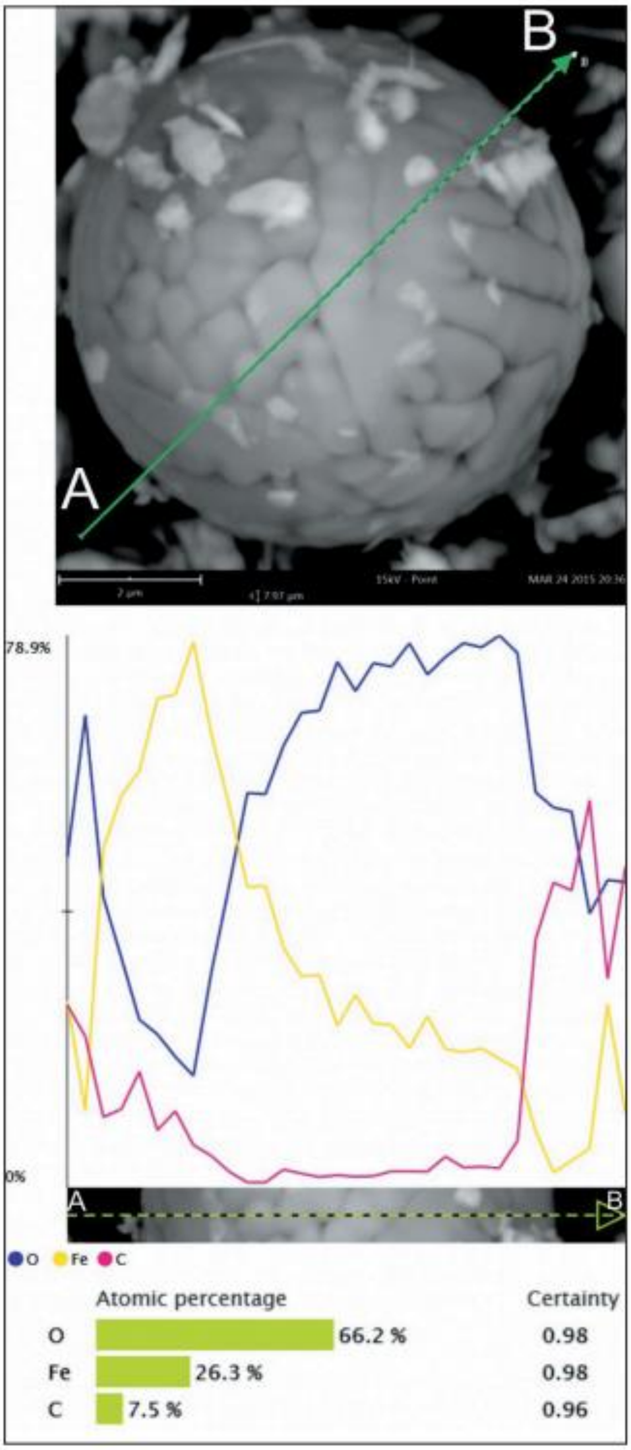

Fig. 8. Chemical composition of the spherical chip (pink color indicates the presence of carbon, purple - oxygen, and yellow - iron)

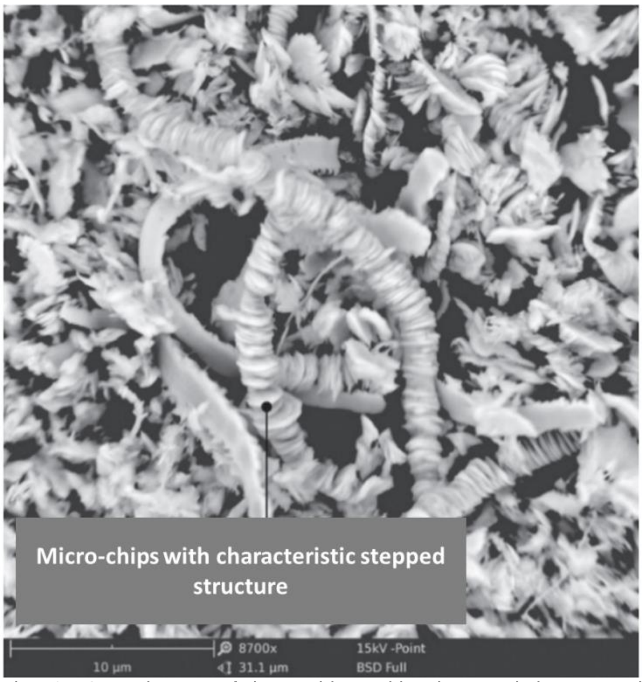

Fig. 9. SEM image of long chips with characteristic stepped construction resulting from micro-smoothing process

Conclusions

During micro-smoothing with abrasive films (during their shelf life and once they are introduced into the treatment zone), a significant amount of whole grains (about 8% of potentially active abrasive grains) is crushed from the tool surfaces. During the analysis of the surface of the abrasive film after the micro-smoothing treatment process, a significant amount of abrasive grains was observed which did not participate in the material separation process, which indicates that abrasive films could be reused in pre-treatment.

During the smoothing process, a very high temperature occurs locally in the processing zone, causing the workpiece to melt and produce spherical chips.

Crushing of the abrasive grains can have a positive effect on the smoothing process - increasing the volume for storing the treatment products.

Too low abrasive film speed can lead to overflow the space between grains and overlapping the surface of the film.

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