UDC 621.923.6: 621.318.4: 621.002.1
DOI: 10.20535/2077-7264.2(88).2025.339238

**© T. Roik, Doctor in Engineering Sciences, Professor, O. Gavrysh, Doctor in Engineering Sciences, Professor, I. Maistrenko, Ph.D., Associate Professor, Igor Sikorsky KPI, Kyiv, Ukraine, K. Jamroziak, PhD, Professor, Wroclaw University of Science and Technology, Wroclaw, Poland**

# ULTRAFINE SUPERFINISHING INFLUENCE ON THE MICROGEOMETRY OF THE PARTS' SURFACES SYNTHESIZED FROM NEW COMPOSITES FOR PRINTING EQUIPMENT' UNITS

**The article focuses on research of the ultrafine finishing influence on the microgeometry of the self-lubricating composite antifriction parts made from new composites based on the cleaned grinding waste from R6AM5 and R6AM5F3 high-speed tool steels with $CaF_2$, which are designed for equipping friction units in printing machines. The experiments were performed on cylindrical samples made of new self-lubricating antifriction composites with the following compositions: R6AM5+(4.0–8.0)%$CaF_2$ and R6AM5F3+(4.0–8.0)%$CaF_2$.**

**Keywords: composite part; steel grinding waste; superfinishing; microgeometry; roughness; irregularities; friction units; printing machine.**

**Introduction**

The quality of high-performance machinery, modern equipment, mechanisms, devices and other equipment is directly related to the characteristics of individual parts that make up units, connections, structural elements, etc.

The stability and reliability of all equipment, including printing equipment, depends on the quality parameters of individual parts [1, 2].

This directly affects the quality of products manufactured on printing machines of various types. This high-performance equipment operates at a wide range of speeds and loads and is also exposed to aggressive environments, such as dust, ink, technological solutions, etc.

The reliable operation of such equipment depends on the quality and reliability of the used components, especially the contact interaction components.

Therefore, particular attention is paid to the quality of friction pair components, since it is these components that are most affected by external loading factors in the operation of printing equipment [1, 2].

These include friction units of offset, printing and moulding cylinders, which are subject to friction and wear under severe operating conditions — with simultaneous rotation speeds of 100 to 5000–10000 rpm loads from 0.5 to 5.0 MPa per friction pair, in air [1, 2].

Due to such a wide range of external stress factors, the improvement of modern printing machines operating in severe conditions requires the use of new materials, the parts of which should have special functional properties, primarily those that significantly increase the stability and reliability of friction units.

Traditionally, cast antifriction parts made of brass, bronze, bimetallic materials, parts with wear-resistant coatings, etc., operating with liquid lubrication, are used in heavy-duty friction units of offset, printing, and moulding cylinders in printing equipment [1, 2].

Such antifriction cast parts are installed in the friction units of many printing machines, in particular, in machines such as SITMA C80 750i, Heidelberg Speedmaster SM 102 FPL, Star Binder 1509, Solna D390 roll-fed offset newspaper printing machines, etc.

Unfortunately, however, these cast antifriction parts are the first to fail due to the constant impact of high loads on the contact pair, possible sudden or emergency stops in the supply of lubricant to the friction zone, etc. This results in intensive wear of the contact parts and malfunctions not only in the friction unit, but also in the entire printing machine as a whole. This causes equipment to stop for the replacement of worn parts, increased downtime, an increase in the number of spare parts, etc., which inevitably leads to a decrease in product quality and an increase in the volume of defective printed products.

This leads to significant financial and material losses.

The above arguments prompted scientists [1, 2] to search for ways to increase the stability and durability of heavy-duty antifriction parts by using fundamentally new materials for their manufacture, followed by fine processing of their working surfaces.

The authors [1, 2] pointed out the wide possibilities of powder technology combinatorics, when, in particular, solid lubricating additives can be added to the initial charge, which cannot be introduced in traditional metallurgical remelting. In this case, powder technology is highly promising and has no alternative.

However, it should be noted that, due to the high cost of raw powders and the equipment used to produce them, the use of powder metallurgy methods is extremely limited.

At the same time, many specialists and researchers are paying increasing attention to the search for alternative and cheap types of raw materials, among which grinding waste from industrial alloys occupies a special place. Such grinding waste is generated during the final grinding operations of cast parts [1]. This source is not only cheap but also extremely valuable raw material, which contains important alloying elements — Ni, Co, W, Mo, V, Nb, Si, Al, Ni, Mn, etc.

Unfortunately, however, such raw materials are not used in the production cycle due to their contamination with abrasive particles

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

from grinding wheels. Such grinding waste is transported to landfills, causing increasing environmental pollution.

The idea of reusing grinding waste as a valuable raw material for creating new composite materials has been reflected in a number of pioneering developments by the authors [1–5].

A number of technological processes have been developed for cleaning metal powders from grinding waste of steels and some non-ferrous metals, which have shown positive results [1–5]. The authors [1–5], in particular, developed new technologies for the recovery and synthesis of new antifriction composites and parts made from them based on cleaned grinding waste from alloyed steels 4KhMNFS, ShKh15, 4Kh2V5MF, and some others with $CaF_2$ solid lubricant. These composites were developed to operate under self-lubricating conditions in high-speed printing machine units and demonstrated high functional properties.

At the same time, it is known that the wear resistance of friction parts in machines and mechanisms is determined not only by their volumetric properties, but also by the quality parameters of surfaces formed during the final mechanical processing [1, 2, 6–10].

Therefore, research into ultrafine methods of abrasive surface processing of friction parts, in particular, the study of superfinishing technological processes, is very important. It is known [7, 11–13] that the superfinishing process forms a micro-relief of Ra ~ 0.02–0.07 μm on the machined surfaces, which is the basis for ensuring a high level of wear resistance, reliability and durability of antifriction parts.

Superfinishing is a finishing process for parts' surfaces using fine-grained abrasive bars that perform oscillatory movements with an amplitude of 2–5 mm at a frequency of 500 to 2000 strokes per minute. [6, 9, 10, 12, 13].

Superfinishing significantly improves the operational properties of parts by ensuring low surface roughness (Rz = 0.6–0.05 μm), removing surface waviness, and significantly reducing burrs (to 0.3–0.5 μm). Superfinishing forms a uniform surface layer without structural changes [6, 9, 10, 12, 13].

The simplicity of the used equipment, high productivity, the ability to operate in an automatic cycle with mechanical loading of parts and active control of their dimensions are among the advantages of superfinishing.

The essence of the process involves microcutting the metal surface simultaneously with a large number of fine abrasive grains [6, 7, 9, 11].

The most intensive cutting occurs when removing the layer of metal with the initial roughness obtained from the previous operation. After its removal, the intensity of the process decreases by about half, and there is a transition from cutting to friction, during which the bar polishes the processed surface. The surface obtains high purity and a mirror-like shine [6, 7, 9, 11].

The main working movements during superfinishing are: rotation of the workpiece at a circumferential speed $V_{cir}$, reciprocating (oscillatory) movement of the bar at a speed $V_{osc}$, longitudinal feed movement of the bar or part at a speed $V_{long.fid}$. In addition to the basic movements, additional movements are sometimes used, for example, ultrasonic vibrations on the bar or part [6, 7, 9].

In mechanical engineering, the most common types of superfinishing are: centre, centreless, end, flat and spherical surfaces.

In all types of superfinishing, the abrasive tool is pressed against the surface being processed with a certain force P. The magnitude of the force is determined depending on the requirements for surface quality and processing productivity [6, 7, 9, 11].

The workpiece is placed in the machine and rotated. An abrasive bar is pressed against the surface being processed with a certain amount of force, performing an oscillating and reciprocating motion along the workpiece's axis.

Unfortunately, research on the superfinishing of composites has been very limited [11]. The obtained superfinishing process results of the composites certain types from waste do not allow generalisations to be made for a wider range of fundamentally new antifriction composites based on grinding waste and parts made from them.

Therefore, carrying out research on the study of ultra-thin abrasive superfinishing processes of self-lubricating antifriction composites based on the cleaned waste of high-speed tool steels R6AM5, R6AM5F3 with $CaF_2$ solid lubricant additives has not only scientific but also practical significance.

Achieving high geometric parameters of machined surfaces after ultra-fine superfinishing will significantly reduce the running-in time of composite parts and substantially increase the wear resistance of the unit due to the rapid formation of anti-seize films on contact surfaces under friction conditions without lubrication.

The above determines the relevance and demand for the chosen research direction and illustrates the significance of the scientific and technical task.

The *objective* of this work is to establish the influence of ultra-fine superfinishing on the formation of the surfaces' microgeometry of self-lubricating composite antifriction parts made from new composites based on the cleaned grinding waste from R6AM5 and R6AM5F3 high-speed tool steels with $CaF_2$ solid lubricant additives.

**Materials and methods**

Cylindrical samples of new self-lubricating antifriction composites based on regenerated grinding waste from R6AM5 and R6AM5F3 high-speed tool steels with $CaF_2$ solid lubricant additives were used in the experiments with the following compositions: R6AM5+(4.0–8.0)%$CaF_2$ and R6AM5F3+(4.0–8.0)%$CaF_2$.

A microscope Optika B1000 MET was used for surfaces' relief visual analysis and counting the number of irregularities at high magnification and also scanning EVO 50XVP electron microscope (SEM).

The mechanical properties of the new composites were determined using standard methods (ISO 4498:2010. Sintered metal materials, excluding hardmetals — Determination of apparent hardness

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

and microhardness, EN ISO 2740: 2009. Sintered metal materials, excluding hardmetals — Tensile test pieces, ISO 5754:2023. Sintered metallic materials, except hard alloys — unnotched impact toughness test specimen) and standard equipment. A UIT GTM 500 testing machine (Ukraine) and a UIT HBW-1 stationary Brinell hardness tester (Ukraine) were used in the study.

Friction and wear tests were carried out according to the end friction scheme on the VMT–1 friction machine under the following conditions: rotation speed 300–400 rpm and load up to 1.0 MPa in air, the counterface was made of R18 steel, which is analogous to tool high-speed steel 1.3355 (DIN standard, Germany) or T1 steel (AISI/ASTM Standard, USA, hardness 54–56 HRC). The R18 steel corresponds to the material of the actual counterface in the friction units of high-speed printing machines.

The samples were subjected to grinding operations followed by ultra-fine superfinishing to obtain comparative surface roughness characteristics after the corresponding mechanical processing. A 63SM7SM2GI, 63SM14SM2GI and 63SM28SM2GI grinding wheels were used for grinding. Superfinishing was performed with a 63SM7SM2GI, 63SM14SM2GI and 63SM28SM2GI abrasive bars.

To achieve the best results, bars with elastic organic bonds (glyphthalic) were used, and a lubricating and cooling fluid with increased viscosity and oiliness was applied during superfinishing with the following composition: oil I-16 (30 %), kerosene (70 %). This allowed superfinishing to be carried out in a friction-polishing mode.

Roughness measurements were performed using a MarSurf PS 10 MAHR needle profilometer (Fig. 1) with automatic recording and storage of results on a PC.

Roundness measurements were performed in accordance with the DSTU EN ISO 1101:2018 Standard ‘Technical requirements for geometric characteristics of products’.

A RON-Pilot roundness tester was used in the experiments (Fig. 2).

The drive for measuring roundness is the drive of the machine tool on which the workpiece being

Fig. 1. MarSurf PS 10 MAHR needle profilometer

studied is processed. The measurement error of this roundness meter does not exceed 10 % of the non-roundness value.

The magnification factor of the roundness pattern changes when measuring geometric deviations on a roundness tester. The roundness tester works by measuring the position of the probe tip relative to the part being measured. During the measurements, the cylindrical part is continuously scanned along its circumference.

The roundness tester calculates individual parameters using an electronic unit and records the roundness diagram. It provides information about the nature of the deviation (ovality, facetting), as well as the limit values of deviations from the ideal profile shape.

**Research results and discussion**

New self-lubricating anti-friction composites were obtained using a previously developed technology [1]. The samples were tested to determine their physical, mechanical, and tribological properties (Table 1).

As it can be seen from Table 1, in terms of physical and mechanical properties, the new composites are practically on the same level as cast bronze C83600 (with the exception of impact toughness), and in terms of antifriction characteristics, they exceed cast bronze C83600, which is traditionally used in friction units of high-speed printing equipment such as Star Binder 1509, Solna D390, etc. [5].

The advantages of new composites (Table 1) are their much higher functional properties due to the presence of solid lubricant in the materials, which is applied to the contact surfaces (mass transfer effect), constantly creates a lubricating film in the contact zone and ensures a constant self-lubrication mode. Cast bronze, on the other hand, is only capable of sta-

Table 1

Physical, mechanical and antifriction properties of new composites

| Chemical composition, wt. % | Bending Strength (ISO 3325-96), $R_{tr}$, MPa | Hardness, HBS 2.5/31.25/15 (ISO 4498-1-90) | Impact toughness (ISO 5754-78), J/m$^2$ | Tribological tests at V = 800–1000 rpm, P = 2.0–3.0 MPa | |
|---|---|---|---|---|---|
| | | | | Friction coefficient | Wear rate, µm/km |
| Composite R6AM5+6$CaF_2$ | 640–660 | 82–85 | 700–720 | 0.17–0.21 | 64.0–72.0 |
| Composite R6AM5F3+6$CaF_2$ | 670–690 | 84–86 | 710–730 | 0.18–0.20 | 66.0–70.0 |
| Bronze cast alloy C83600*(Cu85Sn5Zn5Pb5), C93200 Standard ASTM, USA [5] | 147–240 | 38–40 | 1200–1400 | 0.30–0.42 | 490–520 |

Notes: *— Friction without liquid oil lubrication.

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

ble operation under friction and wear in the presence of liquid lubricant. C83600 cast bronze becomes inoperable without liquid lubricant.

It should be noted that the process of superfinishing was often considered only as a means of reducing the roughness of a part's surface and giving it an attractive appearance [8, 11].

This view was formed on the basis of the existing theory of mechanical engineering technology, when the layer of metal cut off did not exceed 2–3 µm, and the technical essence of processing was considered to be the smoothing of irregularities left over from previous mechanical processing [8, 11]. Further, the intensity of the superfinishing process gradually decreased until it stopped completely.

Recent studies of the technological features of superfinishing [7, 12, 13] involve the use of abrasive bars with increased cutting properties, increased rigidity of the bar pressing system against the surface being treated, control of the intensity of the process, monitoring of the surface layer being processed, and increasing the frequency of vibrations of the abrasive bar up to ultrasonic frequencies. This makes it possible to perform superfinishing with cutting the material's layer of 10–30 µm, while simultaneously eliminating imperfections in the part's geometric shape [11–13].

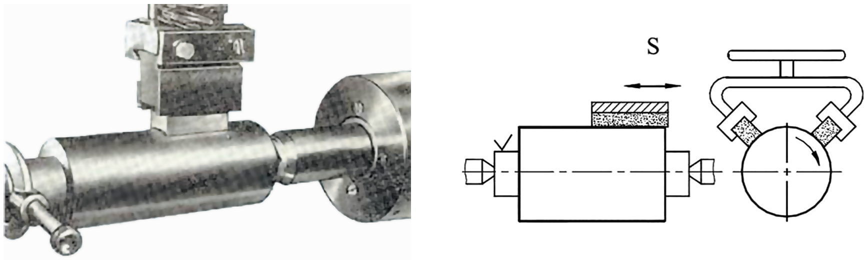
It is known that when an abrasive bar interacts with the surface of a part (Fig. 3) during superfinishing, the material is cut by abrasive grains and the bar's abrasive grains rub along the surface being processed, causing plastic and elastic deformation of its irregularities [6, 7, 9–13].

Therefore, the superfinishing process should be performed in two subsequent stages:

Stage 1 — with predominant cutting — to eliminate the effects of previous machining operations and correct the geometric shape of the part;

Stage 2 — with predominant friction — to obtain minimum roughness parameters Ra.

An important factor for the friction parts fine superfinishing is the formation of such a micro-relief surface, when complete cutting of the waviness formed during previous mechanical processing (grinding) is achieved. This helps to increase the actual part's support surface and, therefore, ensures ra-




a b

Fig. 3. Superfinishing: a — general view; b — superfinishing scheme with two bars [6, 7, 9–13]

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

pid running-in of the contact pair during the start-up periods.

The authors [11] determined that when grinding on normal precision machines, the waviness is on average 1–3 μm, and on high-precision machines — 0.3–0.5 μm. Meanwhile, when using superfinishing, the surface waviness values are within the distribution accuracy of the device — 0.05 μm.

As mentioned above, superfinishing is a type of abrasive finishing process for parts' working surfaces for various purposes. It consistently ensures surface roughness with an Ra parameter in the range of ~ 0.04–0.09 μm.

In this case, the shape, direction and frequency of micro-irregularities can be subjected to regulation due to changes in the mechanism and kinematics of the superfinishing process [6, 7, 9–13].

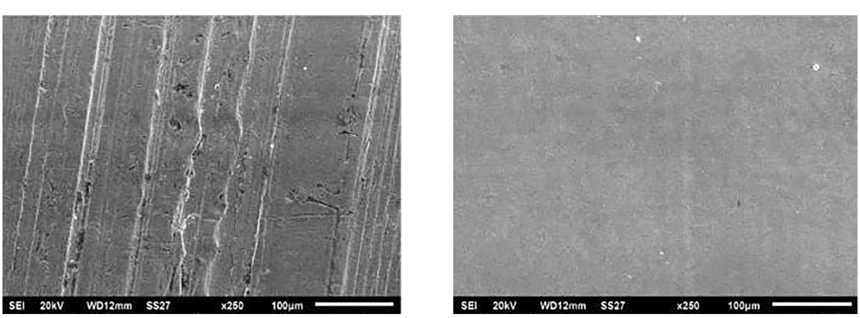
This was confirmed by studies the influence of superfinishing on the samples' surface made of new composites. The use of scanning electron microscopy made it possible to visualize the actual changes in the topographical relief of surfaces after superfinishing (Fig. 4).

The microgeometry of the sample surface changed significantly after fine superfinishing, as can be seen from the microphotographs taken at the same magnification (Fig. 4). It represents a micro- or even nanogeometric relief, which is a positive factor for obtaining the highest quality parameters of working surfaces. In addition, superfinishing helped to eliminate shape defects after surfaces' preliminary grinding of the studied cylindrical samples, as can be seen from the roundness diagrams obtained (Fig. 5).

There is a decrease in the height of irregularities by approximately 35–40 % as a result of changing the predominant cutting mode in the superfinishing process to the friction-polishing mode due to their plastic deformation.

High Ra roughness parameters after superfinishing were obtained on both types of studied composites based on cleaned grinding waste of R6AM5 and R6AM5F3 steels.

Superfinishing creates a large number of irregularities on the processed surface.

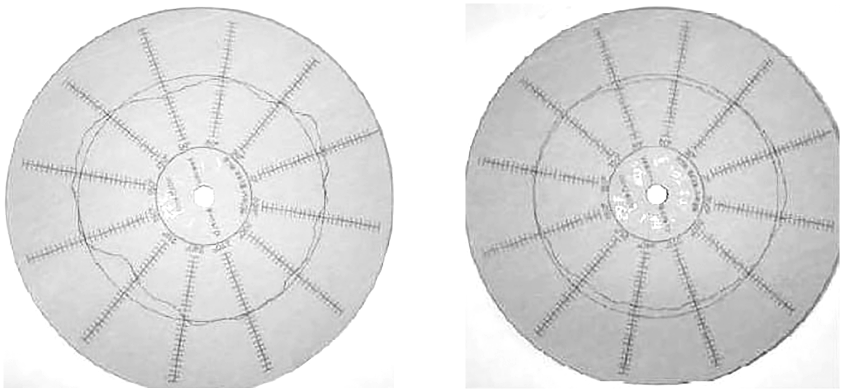



a b

Fig. 4. Surface of processing before (a) and after (b) superfinishing of composite samples R6AM5F3+(4.0–8.0)%$CaF_2$, scanning electron microscopy (SEM)

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)



a b

Fig. 5. Roundness diagrams of R6AM5+(4.0–8.0)%$CaF_2$ samples: a — after diamond grinding; b — after superfinishing, magnification — ×2000

For example, when grinding workpieces made of R6AM5 steel-based composite with a green silicon carbide wheel with a grain size of 7 μm on a glyphtal bond (63SM 7SM2Gl), approximately 30–40 irregularities per 1 mm of surface length are formed, with Ra roughness within the range of 0.17–0.25 μm.

And when superfinishing with a bar of the same composition with a grain size of 7 μm (63SM7SM2Gl), significantly more irregularities are formed — 140–150 per 1 mm of surface length, with an Ra parameter within the range of 0.05–0.08 μm.

Table 2 shows the results of the distribution of height irregularities on the samples' surfaces made of composite based on R6AM5+(4.0–8.0)%$CaF_2$ steel waste, which were pre-grinded and then superfinished.

It should be noted that the number of irregularities after superfinishing is significantly higher than after grinding (Table 2). This can be explained by the action of the finest abrasive microparticles large number and the presence of the abrasive bar high-frequency vibrations [7, 11].

At the same time, the radii r of the micro-irregularities rounded tops also differ from the machined surface, both in the cutting mode and in the friction-polishing mode during superfinishing.

The tops' radii rounded of the irregularities (r) are within the range of 12–16 μm after grinding. The values of the radii r and their percentage ratio after superfinishing are presented in Table 3.

As can be seen from Table 3, changing the nature of the interaction between abrasive grains and the surface being processed, namely, changing the cutting mode to a friction-polishing mode, leads to a significant increase in the radii r of the rounded tops of irregularities. This factor is useful for increasing the contact stiffness of composite parts directly in the friction unit.

This makes it possible to control the formation of the irregularities orientation during superfinishing by changing the ratio of work-

Table 2

Distribution of surface irregularities by height

| Highest point level of profile, μm | Number of irregularities per 1 mm of length | | | |
|---|---|---|---|---|
| | Roughness parameters Ra = 0.17–0.25 μm | | Roughness parameters Ra = 0.05–0.08 μm | |
| | grinding | superfinishing | grinding | superfinishing |
| 0.10 | 2 | 5 | 2 | 15 |
| 0.15 | 3 | 8 | 6 | 40 |
| 0.20 | 4 | 13 | 18 | 89 |
| 0.25 | 6 | 18 | 54 | 115 |
| 0.30 | 9 | 23 | 62 | 150 |
| 0.35 | 14 | 36 | — | — |
| 0.40 | 22 | 43 | — | — |
| 0.45 | 32 | 52 | — | — |
| 0.50 | 44 | 73 | — | — |

Note: 1. A 63SM7SM2Gl grinding wheel was used for grinding. 2. Superfinishing was performed using a 63SM7SM2Gl abrasive bar. 3. A lubricating and cooling fluid with the following composition was used for superfinishing: industrial oil I-16 (30 %), kerosene (70 %).

ing movements. This, in turn, will contribute to the rapid running-in of contact parts and stabilisation of the unit as a whole.

At the same time, it is not possible to change the irregularities orientation during grinding, and the traces of surface processing with abrasive grains have a constant direction due to the rotation of the grinding wheel.

The above phenomena in the surface layer of the studied composites are usually fixed at a depth

Table 3

Radii r of the irregularities top rounding during superfinishing samples from the composite based on steel waste R6AM5F3

| Abrasive bar | Superfinishing mode | Number of irregularities, % | | | | |
|---|---|---|---|---|---|---|
| | | Radius of rounding of irregularities, r, μm | | | | |
| | | 10–25 | 25–45 | 45–80 | 80–190 | 190–310 |
| 63SM28SM2Gl | Cutting | 54 | 23 | 15 | — | — |
| 63SM28SM2Gl | Friction–polishing | 3 | 14 | 62 | 19 | 5 |
| 63SM14SM2Gl | Cutting | 42 | 34 | 17 | — | — |
| 63SM14SM2Gl | Friction–polishing | 24 | 5 | 60 | 25 | 6 |

Note: 1. Superfinishing mode — part speed $v_p$ = 100 m/min; longitudinal feed $vl_{ong.f.}$ = = 1.0 m/min, specific pressure of bars q = 0.8 MPa. 2. Composition of the lubricating and cooling fluid during superfinishing — industrial oil I-16 (30 %), kerosene (70 %).

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

of up to 10–12 μm. The most significant effect is observed in the ultra-thin layer with a depth of up to 2 μm.

Summarizing the obtained results, it can be confidently stated that, from the point of view of the formed surface microgeometry, the technological process of superfinishing new antifriction composites based on the cleaned grinding waste has significant advantages compared, for example, to grinding.

These advantages include ensuring minimum surface roughness parameters Ra, eliminating waviness from previous processing, developed geometry of irregularities, which contributes to an increase in the actual support surface, and the ability to control these characteristics by changing the processing modes. All this makes it possible to recommend the technological process of superfinishing new self-lubricating composite parts based on cleaned grinding waste of R6AM5 and R6AM5F3 steels with $CaF_2$ solid lubricant as an effective finishing operation in the manufacture of parts for printing machines' friction units.

**Conclusions**

The results of this study allow us to draw conclusions that may be very useful from a practical point of view.

For the first time, the features of fine abrasive superfinishing for fundamentally new self-lubricating composites made from cleaned grinding waste of R6AM5 and R6AM5F3 tool steels with $CaF_2$ solid lubricant additives have been studied.

Such fine finishing significantly changes the microgeometry of the surface. The microgeometry of the surface is a micro- or even nanogeometric relief, which is a positive factor for obtaining the highest quality parameters of the parts' working surfaces.

In addition, superfinishing helped to eliminate defects in the shape, namely, waviness that formed after preliminary grinding of the studied cylindrical samples' surfaces.

It has been demonstrated the height of irregularities decreases by approximately 35–40 % due to their plastic deformation as a result of changing the predominant cutting mode to the friction-polishing mode in the superfinishing process. High Ra roughness parameters after superfinishing were obtained on both types of the studied composites based on cleaned grinding waste of R6AM5 and R6AM5F3 steels.

It has been shown superfinishing creates a large number of irregularities on the processed surface compared to abrasive grinding with a tool of similar composition. Thus, when grinding workpieces made of R6AM5 steel-based composite with a green silicon carbide wheel with a grain size of 7 μm on a glyphtal bond (63SM7SM2Gl), ≈30–40 irregularities per 1 mm of surface length are formed, with a roughness of Ra within the range of 0.17–0.25 μm. And when superfinishing with a bar of the same composition with a grain size of 7 μm (63SM7SM2Gl), significantly more irregularities are formed ≈140–150 per 1 mm of surface length, with an Ra parameter within the range of 0.05–0.08 μm.

Studies have shown changing the cutting mode to friction polishing mode during superfinishing leads to a significant increase in the radii r of the rounded tops of irregularities. This factor is positive for increasing the contact stiffness of composite parts directly in the friction unit.

Experiments showed it is possible to control the formation of the irregularities orientation during superfinishing by changing the ratio of working movements. This, in turn, will contribute to the rapid running-in of contact parts and stabilization of the friction unit operation and the printing machine as a whole.

Further research will focus on determining the characteristics of surface quality parameters during superfinishing of new composites made from non-ferrous alloy grinding waste.

**References/Список використаної літератури**

1. Kyrychok, P. O., Roik, T. A., Gavrysh, O. A., Maistrenko, Iu. Iu., & Oliinyk, V. H. (2024). *Prohresyvni tekhnolohii syntezu i tonkoi obrobky novykh antyfryktsiinykh kompozytnykh detalei dlia vuzliv drukarskykh mashyn [Progressive technologies of synthesis and fine processing of new antifriction composite parts for components of printing machines. Part 1]*. Kyiv: ArtEk Publishing House, 268 p. Retrieved from https://ela.kpi.ua/handle/123456789/42300 [in Ukrainian].

2. Kyrychok, P. O., Roik, T. A., Gavrysh, O. A., Maistrenko, Iu. Iu., & Oliinyk, V. H. (2025). *Prohresyvni tekhnolohii syntezu i tonkoi obrobky novykh antyfryktsiinykh kompozytnykh detalei dlia vuzliv drukarskykh mashyn [Progressive technologies of synthesis and fine processing of new antifriction composite parts for components of printing machines. Part 2]*. Kyiv: ArtEk Publishing House, 282 p. Retrieved from https://ela.kpi.ua/handle/123456789/72196 [in Ukrainian].

3. Jamroziak, K., & Roik, T. (2021). Friction Films and Their Influence on the Antifriction Properties of New High-Temperature Nickel Composites. In: Abdel Wahab M. (eds) Proc. of the 8th International Conference on Fracture, Fatigue and Wear. FFW 2021, 601–611. *Lecture Notes in Mechanical Engineering*, Springer, Singapore. https://doi.org/10.1007/978-981-15-9893-7_44 [in English].

4. Roik, T., Rashedi, A., Khanam, T., Chaubey, A., Balaganesan, G, & Ali, S. (6th August 2021, Basel, Switzerland). Structure and properties of new antifriction composites based on tool steel grinding waste. *Journal 'Sustainability' MDPI Open Access Publishing*, Vol. 13, Issue 16, No 8823, 1–10. https://doi.org/10.3390/su13168823 [in English].

5. Roik, T., Gavrysh, O., Rashedi, A., Khanam, T., Raza, A., & Jeong B. (27.02.2022). New Antifriction Composites for Printing Machines Based on Tool Steel Grinding Waste. *MDPI Journal 'Sustainability', Section 'Sustainable Materials', Special Issue 'Materials for Sustainability'*, Vol. 14, Issue 5, 1–11. https://doi.org/10.3390/su14052799 [in English].

6. Gavrish, A. P., & Melnychuk, P. P. (2004). *Finishna almazno-abrazyvna obrobka mahnitnykh materialiv [Finishing diamond-abrasive processing of magnetic materials]*. Zhytomyr: Zhytomyr State Technological University, 551 p. Retrieved from http://www.ukrbook.net/litopys/Knigki/2005/Lk_9_05.pdf [in Ukrainian].

ISSN 2077-7264. Технологія і техніка друкарства. 2025. № 2(88)

7. Dziura, V. O., & Marushchak, P. O. (2021). *Tekhnolohichni metody zabezpechennia parametriv yakosti poverkhon til obertannia ta yikh profilometrychnyi kontrol [Technological methods for ensuring the quality parameters of rotating body surfaces and their profilometric control]*. Ternopil: FOP Palianytsia V. A., 170 p. Retrieved from https://elartu.tntu.edu.ua/bitstream/lib/36000/1/Monohrafiya_2021.pdf [in Ukrainian].

8. Mazur, M. P., & et al. (2020). *Osnovy teorii rizannia materialiv [Fundamentals of the theory of cutting materials]*. Lviv: New World, 2000, 471 p. Retrieved from http://ns2000.com.ua/wp-content/uploads/2019/11/Osnovy-teorii-rizan.mater.pdf [in Ukrainian].

9. Gavrysh, A. P., & Melnychuk, P. P. (2003). *Almazno-abrazyvna obrobka mahnitnykh materialiv [Diamond-abrasive processing of magnetic materials]*. Zhytomyr: ZhDTU, 652 p. Retrieved from https://scholar.google.ru/citations?view_op=view_citation&hl=uk&user=_WDjjTQAAAAJ&citation_for_view=_WDjjTQAAAAJ:u5HHmVD_uO8C [in Ukrainian].

10. Novikov, M. V. (2006). *Abrazyvni materialy. Entsyklopediia Suchasnoi Ukrainy [Abrasive materials. Encyclopedia of Modern Ukraine]*. Kyiv: Institute of Encyclopedic Studies of NAS of Ukraine. Retrieved from http://esu.com.ua/search_articles.php?id=42203 [in Ukrainian].

11. Gavrysh, A. P., Roik ,T. A., Lototska, O. I., & Vitsyuk, Yu. Yu. (2015). Mikroheometriia poverkhni ta stan poverkhnevoho sharu znosostiikykh detalei tertia z vysokolehovanykh kompozytiv za umovy abrazyvnoho superfinishuvannia [Microgeometry of the surface and condition of the surface layer of wear-resistant friction parts made of high-alloy composites under abrasive superfinishing]. *Scientific Bulletin of NTUU 'KPI'*, 5, 81–88. Retrieved from https://ela.kpi.ua/server/api/core/bitstreams/c180682e-986a-4b34-9ca2-da872987bf04/content [in Ukrainian].

12. Chumak, A. O., Melniichuk, Y. O., & Klymenko, S. A. (2022). Osoblyvosti finishnoi obrobky robochykh elementiv rizalnykh instrumentiv iz polikrystalichnoho kubichnoho nitrydu boru hrupy BL [Features of working cutting tools elements' finishing from polycrystalline cubic boron nitride of group BL]. *Technical Engineering*, 1(89), 55–61. DOI: 10.26642/ten-2022-1(89)-55-61 [in Ukrainian].

13. Novikov, M. V., Shepeliev, A. O., Klymenko, S. A., & Lavrinenko, V. I. (2005). Tekhnolohii mekhanoobrobky instrumentamy z nadtverdykh materialiv i tverdykh splaviv u INM im. V. M. Bakulia NAN Ukrainy [Technologies of machining with tools from superhard materials and hard alloys at the V. M. Bakul Institute of Superhard Materials of the National Academy of Sciences of Ukraine]. *Machining processes in mechanical engineering*, 2, 91–100. Retrieved from https://library.ztu.edu.ua/e-copies/Zbirnyk/Process_obrobky_2/91.pdf [in Ukrainian].

**Стаття фокусується на дослідженнях зі встановлення впливу надтонкого оздоблювального суперфінішування на формування мікрогеометрії поверхонь самозмащувальних ком-**

**позитних антифрикційних деталей з нових композитів на основі очищених шліфувальних відходів інструментальних швидкорізальних сталей R6AM5 і R6AM5F3 з домішками твердого мастила $CaF_2$, що призначені для оснащення вузлів тертя друкарської техніки. Експерименти виконувались на циліндричних зразках з нових самозмащувальних антифрикційних композитів наступних складів: R6AM5+(4.0–8.0)%$CaF_2$ та R6AM5F3+(4.0–8.0)%$CaF_2$.**

**Ключові слова: композитна деталь; шліфувальні відходи; суперфінішування; мікрогеометрія; шорсткість; нерівності; вузли тертя; друкарська машина.**

Надійшла до редакції: 30.05.25

Рецензія: 17.06.25

Опубліковано: 30.06.25