

Wear Evaluation of the Rotors of Open End Spinning Machines

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Abstract

This paper presents the results of an observation and investigation into the wear of the rotors of an open end spinning machine mating with wool yarn in industrial conditions. The rotors were made of alloys EN AW-2024 (AlCu4Mg1) and EN AW-6082 (AlSi1MgMn) after a process of hard anodic oxidation in industrial conditions. Analysis of the wear process together with the decrease in the oxide layer thickness before and after the operation certifies that such a layer assures at least a two and a half fold increase in wear resistance. The surface topography and microstructure of the surface layer before and after the period of operation were assessed, which allowed us to establish that the wear of the inner surfaces of the rotor in the collecting groove caused by the friction of impurities and yarn on their surfaces is mainly determined by the abrasive wear.

Key words: spinning machine, rotor, abrasive wear.

Introduction

The basic sub-assembly of every open end-spinning machine based on the rotor spinning process [1, 2] is a spinning head with a rotor as the most important element. Several years' observations of open end spinning machines of the type PW12, manufactured by BEFAMA (Poland), carried out in industrial plants, have shown that the rotor is the least durable element of the machine.

The inner surfaces of the rotor should feature a low coefficient of friction on contact with the yarn, which mainly depends on the surface topography (surface geometric structure – SGS 3D) and method of manufacturing. It should not generate a static charge nor load the yarn electrostatically. It should be highly resistant to wear and any accidental dynamic loads generated by the high speed of moving solid particles and the reaction of the yarn.

In order to fulfil the conditions above, the application of proper materials, types and methods of machining that guarantee the obtainment of a proper surface layer from a technological and operational point of view is required. The material should feature a high unit strength at low density, ensuring small forces and inertia moments. The dielectric properties, high wear resistance and low adhesion of the yarn are also of great importance. However, the technology of manufacturing should guarantee the obtainment of such a surface structure that ensures the high quality, low friction and proper wear resistance of the yarn manufactured; as a consequence, the efficiency and durability will increase. The well known manufacturers of open end spinning machines produce the rotors from special steel or aluminium alloys.

Rotors made of steel are either subjected to a hardening operation or a diamond layer or boron is applied to its inner surface. In the case of rotors made of aluminium alloys, a diamond layer or diamond and nickel [2] layers are applied.

The aim of this work was to evaluate the effect of a significantly cheaper method of the surface hardening of machine elements manufactured from aluminium and its alloys by so called hard anodic oxidation on the durability of rotors. In the process of hard anodic oxidation, a hard anodic oxide Al_2O_3 coating of high porosity and abrasive wear resistance is formed upon the aluminium surface and its alloys. The optimum thickness of the oxide layer does not usually exceed a value of 0.03 mm, depending upon the type of alloy and such process parameters as electrolytic solution, its temperature, current density and the process duration [3, 4].

The results presented in this paper are the continuation of research described in [5].

In spite of fact that the production of rotor spinning machines in Poland has actually ceased, the results of the operational tests obtained can be successfully utilised in other types of textile machines.

Method of the wear evaluation of the rotors of open end spinning machines

Several years' observations of the rotors in open end spinning machines operating in industrial conditions have shown that mainly the inner surface of the rotor: conical C and the collecting groove undergo a wear process (Figure 1). Investigations of the wear of the rotors of open end spinning machines were restricted to the inner sur-

Denotations used

- S_a - the arithmetical mean height,
- S_q - the rot mean square deviation,
- S_p - the maximum peak height,
- S_v - the lowest valley of the surface,
- S_t - the maximum height of the topographic surface,
- S_k - the surface core depth,
- S_{pk} - the reduced peak height,
- S_{vk} - the reduced valley depth,
- S_{mr1} - the peak material component,
- S_{mr2} - the valley material component.

faces of the collecting groove, R_{cg} , because the wear intensity of these surfaces is several hundred times larger than that of the conical inner surface C of the rotor. In the case of rotors made of aluminium alloys without a hard layer on their inner surfaces, the wear is disastrous as the rotor is cut into two parts in its collecting groove [6].

Wear evaluation of the rotors in the collecting groove was carried out during the manufacturing process of polyacrylonitril yarn of linear mass 350 - 500 tex (350 - 500 mg/m) on an open end spinning machine of the type PW-12, with the number of spinning points equal to 54. The operational parameters of the spinning machine were as follows:

- rotational speed of rotors
 $n_r = 18000$ r.p.m.,
- rotational speed of opening rollers
 $n_{wl} = 3400$ r.p.m., and
- linear output velocity of yarn
 $v_w = 90 - 120$ m/min.

The rotors were made of semi-finished product in the form of a 150 mm diameter squeeze-out bar, which was machined by turning so that the radial run-out of all faces and diameters over $\varnothing 40$ mm did not exceed a value of 25 μ m.

Investigations were carried out on rotors made of the following aluminium alloys:

- EN AW-2024 (AlCu4Mg1) - the inner surfaces were subjected to the following method of finishing: grinding with an abrasive cloth of a grain size of 150 and 220, followed by polishing with a felt disc saturated with polishing paste;
- EN AW-6082 (AlSi1MgMn) - the inner surfaces were subjected to the following surface operations and finishing treatment: grinding, polishing, hard anodic oxidation [3], grinding with an abrasive cloth of 240 and 360 grain size, as well as with abrasive paper of 600 grain size.

The rotors made of alloy EN AW-6082 only and subjected to hard anodic oxidation underwent durability investigations because a hardness of over 7000 MPa, which determines the tribological properties of the oxide layers, can only be obtained for this particular alloy, whereas a value of 2850 MPa can be reached in the case of alloy EN AW-2024 [6].

Hard anodic oxidation [3, 4] was conducted in electrolytic solution with the following chemical composition (depending on

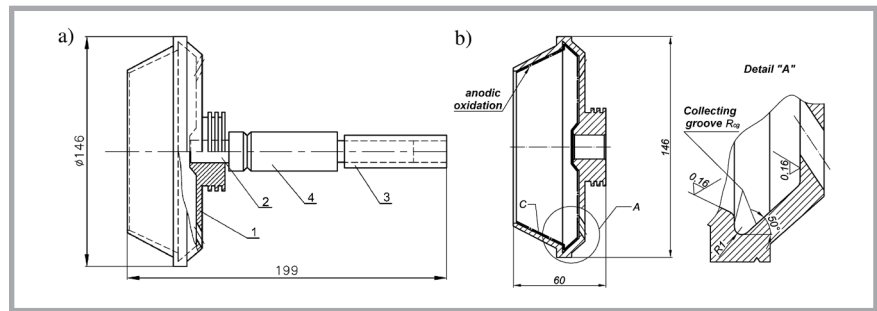


Figure 1. Rotor of open end spinning machine PW-12: a) complete rotor with a drive pulley of belt and bearing: 1 – rotor; 2 – cylindrical needle, 3 – spindle cap (drive pulley), 4 – bearing SKF-18CN-AA 74077; b) rotor with the marked profile of the collecting groove.

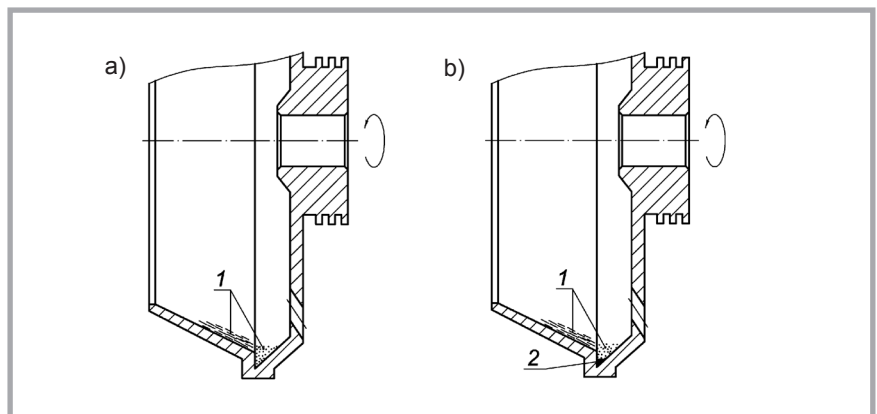


Figure 2. Impurities deposited in the collecting groove of a rotor: a) rotor at the start of operation; b) rotor after the operation (some tens of hours); 1 - fibers, 2 - impurities.

the weight): sulphuric acid - 6%, sulphosalicylic acid - 3%, lactic acid - 2%, glycerine - 2%, aluminium sulphate - 0.1%; the rest being distilled water. The conditions of anodic oxidation were as follows: direct current + alternating with a part of the positive component – 85 %, anodic current density - 3 A/dm², temperature of the electrolytic solution -2 °C up to 6 °C, and time of anodic oxidation 40 minutes. A cathode was placed inside the rotor. The mixing of the electrolyte was carried-out by rotating the rotor at a speed of about 130 r.p.m. Before the hard anodic oxidation, the following operations were carried out to prepare the surface: degreasing in an organic solvent, then etching for two minutes in a 5% solution of sodium hydrate, and finally flushing with water.

The wear of the inner surface of the collecting groove, R_{cg} , of the rotors was determined by measurement of selected parameters of the surface topography before and after the operation [7], which was carried out using a Mahr Pethometer Concept profilometer. Measurements of the surface topography were carried out on surfaces of 2.0 × 2.0 mm by making 401 profiles at distances of 5 μ m. The following parameters were assumed for the profile meas-

urements: the cut off $l_r = 0.25$ mm (Gaussian filter was used), the evaluation length $l_t = 2.8$ mm, the number of registered points $N_x = 8000$, the sampling interval $\Delta_x = 0.35$ μ m, the stylus radius of the profilometer $r_{tip} = 2$ μ m, and the measurement velocity $v_{os} = 0.5$ mm/s.

The surface topography was evaluated by the following parameters of the surface geometric structure (SGS) [8, 9]: amplitude parameters – arithmetical mean height S_a , root mean square deviation S_q , maximum peak height S_p , the lowest valley of the surface S_v , maximum height of the topographic surface S_t and the parameters obtained from the material ratio curve: the surface core depth S_k , the reduced peak height S_{pk} , the reduced valley depth S_{vk} , the peak material component S_{mr1} and the valley material component S_{mr2} . The wear in the collecting groove was additionally determined by comparison of the groove profile R_{cg} before and after the operation [7]. Therefore specimens of about 5 mm width were cut in the axial plane of the rotors selected. Profiles of the collecting groove were registered with a Neophot 2 microscope at a 10×, 20×, and 60× magnification. However, the microstructure of the oxide layer in the collecting groove

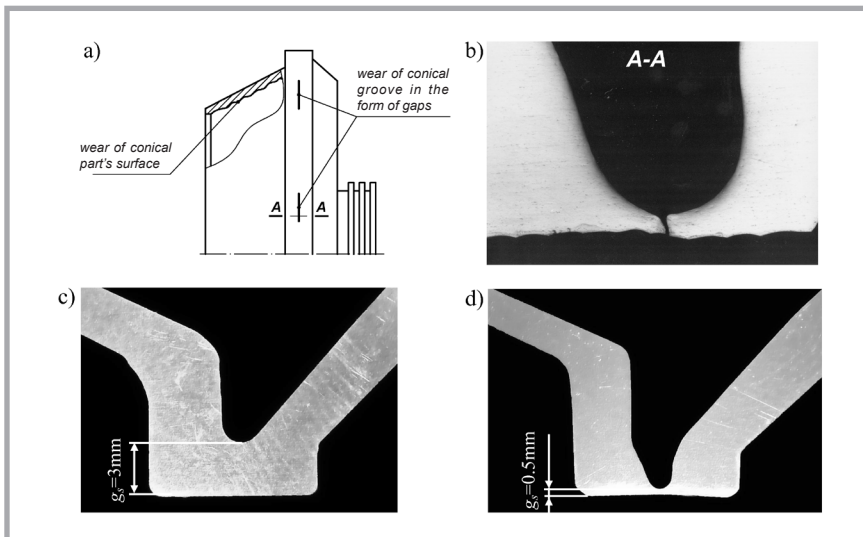


Figure 3. Inner surfaces of a rotor made of alloy EN AW-2024 subjected to the wear process during operation: a) wear of conical surface C and in the collecting groove R_{cg} ; b) picture of a transverse metallographic specimen of the collecting groove, R_{cg} , of the rotor after an operation period of about 6000 hours (wear in the shape of a crack), magnification $60\times$; c) picture of a transverse metallographic specimen of the collecting groove, R_{cg} , of the rotor before operation, magnification $10\times$; d) picture of transverse metallographic specimen of collecting groove R_{cg} of the rotor after an operation period of about 6000 hours, magnification $10\times$.

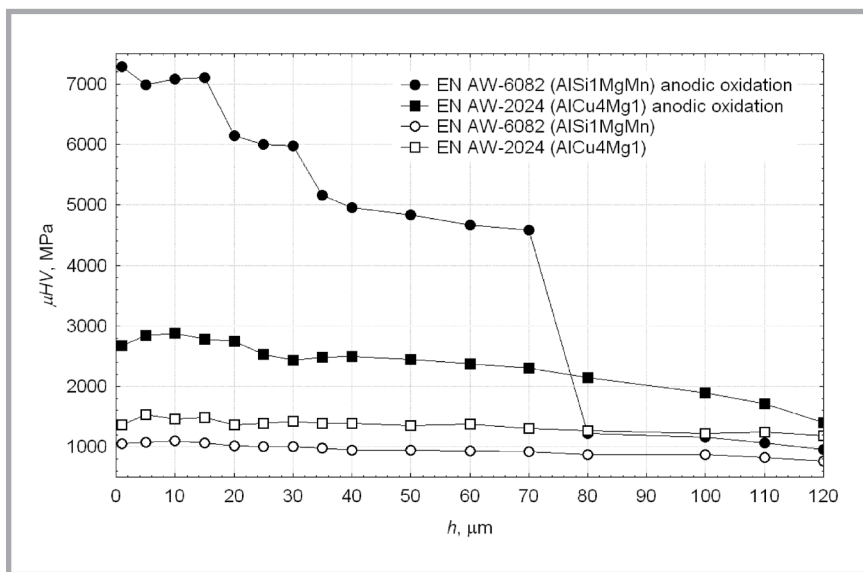


Figure 4. Micro hardness distributions in the surface layer of rotors made of alloys EN AW-2024 and EN AW-6082 in the function of the distance from the surface for different surface types and finishing treatments.

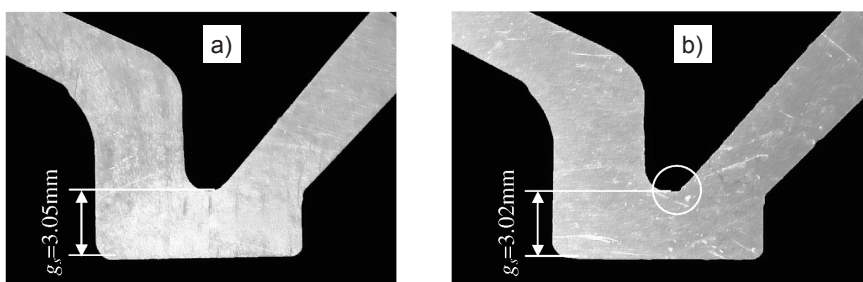


Figure 5. Profile of the collecting groove of a rotor made of alloy EN AW-6082 after hard anodic oxidation before and after operation: a) picture of a transverse metallographic specimen of the collecting groove, R_{cg} , of the rotor before exploitation, magnification $10\times$; b) picture of a transverse metallographic specimen of the collecting groove R_{cg} of the rotor after an operation period of about 9000 hours, magnification $10\times$.

was analysed before and after at a magnification of $300\times$.

Microhardness measurements of the surface layer were carried out on inclined metallographic specimens at an angle of $1^\circ30'$ (0.026 rad), with the application of a Leitz Wetzlar micro hardness tester at an indenter load of 0.245 N.

Micro pictures of the inner surface in the collecting groove, R_{cg} , of the rotors were taken with a Jeol JSM-5500LV scanning microscope at magnifications of $200\times$ and $1000\times$.

Wear of inner surfaces in the collecting groove of the rotor

During the operation of a rotor spinning machine, part of the hard impurities of the fibre strip is placed in the collecting groove of the rotor by the centrifugal force (Figure 2, see page 37), which worsens the control of yarn formation and decreases the yarn strength. Accelerated wear of the rotors is generated by their non-uniform thinning on the peripheral wall in the collecting groove (Figure 3). This process generates 'cracks' and, in consequence, the cutting off of the rotor cone (Figure 3.b). The geometric structure of the conical surface, C , undergoes significant changes.

In the case of non-hardened surfaces, i.e. of μHV hardness, which does not exceed 1500 MPa, it was possible to observe a five-fold increase in roughness. Again, in the case of surfaces with a hardness of about $\mu HV = 7000$ MPa (after anodic oxidation), a decrease in roughness of about $30 - 35\%$ [6] was found.

As an example, the roughness of the inner conical surface, C , (Figures 1.b and 3.a) of rotors made of alloy EN AW-2024 after the finishing treatment was $R_a = 0.30$ to 0.42 μm , whereas in the case of rotors made of alloy EN AW-6082, after hard anodic oxidation and grinding with a cloth and abrasive paper, the roughness was $R_a = 1.30 - 1.50$ μm . In the case of rotors made of alloy EN AW-2024, after an operation period of about 6000 hours, a significant increase in roughness occurred $R_a = 1.6 - 2.0$ μm . Again, in the case of the rotors made of alloy EN AW-6082 treated by anodic oxidation, a slight decrease in surface roughness $R_a = 1.0 - 1.1$ μm [6] was observed.

The effect of the material type and surface treatment by the hard anodic oxidation of rotors made of alloys EN AW-2024 and EN AW-6082 upon the micro hardness distribution is shown in **Figure 4**. The maximum micro hardness in the surface layer of rotors made of alloy EN AW-6082 occurred at a depth of about 10 μm , amounting to 1050 MPa, whereas in the case of rotors made of alloy EN AW-2024, it happened at a depth of about 5 μm , reaching a value of 1550 MPa, respectively. The application of hard anodic oxidation to rotors made of alloy EN AW-6082 allowed to obtain a maximum micro hardness in the surface layer of about 7280 MPa, whereas for rotors made of alloy EN AW-2024 – at a depth of about 10 μm - it amounted to a value of about 2850 MPa. The tribological properties of the oxide layers and, in particular, the wear resistance depend mainly on their hardness [10].

The wear in the collecting groove of rotors that has not undergone hard anodic oxidation has the form of a narrowing cavity, rounded at the bottom, 2.5 - 3.0 mm deep and about 2.0 mm wide at its upper part. This cavity is slightly deflected to the side of the rotor bearing. **Figure 5.a** shows the form of the collecting groove after hard anodic oxidation and before the operation of rotors, whereas **Figures 5.b, 6.a** and **6.b** show the form of the collecting groove after a period of exploitation of about 9000 working hours. At 10 times magnification (**Figure 5.b**), the wear in the collecting groove is almost invisible, whereas at a magnification of 300 times the wear exhibits the form of a cavity with rounded bottom corners of about 280 μm width and 60 μm depth. The hard oxide layer in the collecting groove was worn in the place where the curved linear surface penetrates the conical surface, inclined at an angle of 50°; the damage was caused by the moving particles of solid impurities during the rotational motion of the rotor. On both sides of the wear, a 15 μm - 20 μm thick oxide layer is visible. As in the case of non-oxidised rotors, wear in the shape of a cavity does not occur at the very bottom but in a place slightly shifted in the direction of the system of bearings, which is caused by the action of centrifugal and Coriolis forces as well as by under pressure acting on the yarn.

Table 1 shows the measurement results of selected parameters of the 3D geometric structure of the collecting groove surface, R_{cg} , inclined at an angle of 50°, of rotors made of alloy EN AW-2024 be-

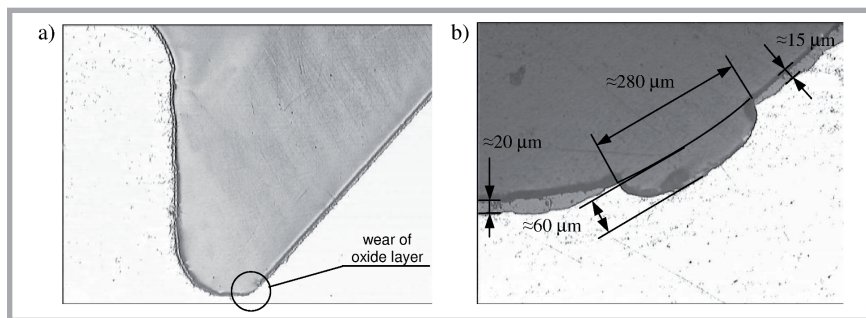


Figure 6. Wear form of the oxide layer in the collecting groove R_{cg} of a rotor made of alloy EN AW-6082 after an operation period of about 9000 hours: a) wear in the collecting groove, magnification 20 \times ; b) wear in the collecting groove, magnification 300 \times .

Table 1. Values of selected parameters of the 3D surface topography of the collecting groove surface, R_{cg} , inclined at an angle of 50° for rotors made of alloy EN AW-2024 before and after an exploitation period of about 6000 operating hours, as well as for those made of alloy EN AW-6082 after hard anodic oxidation before and after a period of exploitation of about 9000 operating hours.

Parameters of 3D surface topography	Rotors made of alloy EN AW-2024 (AlCu4Mg1)		Rotors made of alloy EN AW-6082 (AlSi1MgMn), hard anodic oxidation	
	Before operation	After operation (about 6000 operating hours)	Before operation	After operation (about 9000 operating hours)
$S_a, \mu\text{m}$	0.13	0.67	0.46	0.39
$S_q, \mu\text{m}$	0.20	0.87	0.67	0.64
$S_p, \mu\text{m}$	1.05	8.61	1.93	6.28
$S_v, \mu\text{m}$	1.79	5.87	6.09	8.76
$S_t, \mu\text{m}$	2.84	14.47	8.02	15.04
$S_k, \mu\text{m}$	0.46	4.34	0.90	2.41
$S_{pk}, \mu\text{m}$	0.02	0.08	0.03	0.13
$S_{vk}, \mu\text{m}$	0.51	1.25	1.66	3.88
$S_{mr1}, \%$	7.73	8.07	8.68	8.82
$S_{mr2}, \%$	85.90	85.62	77.52	87.67

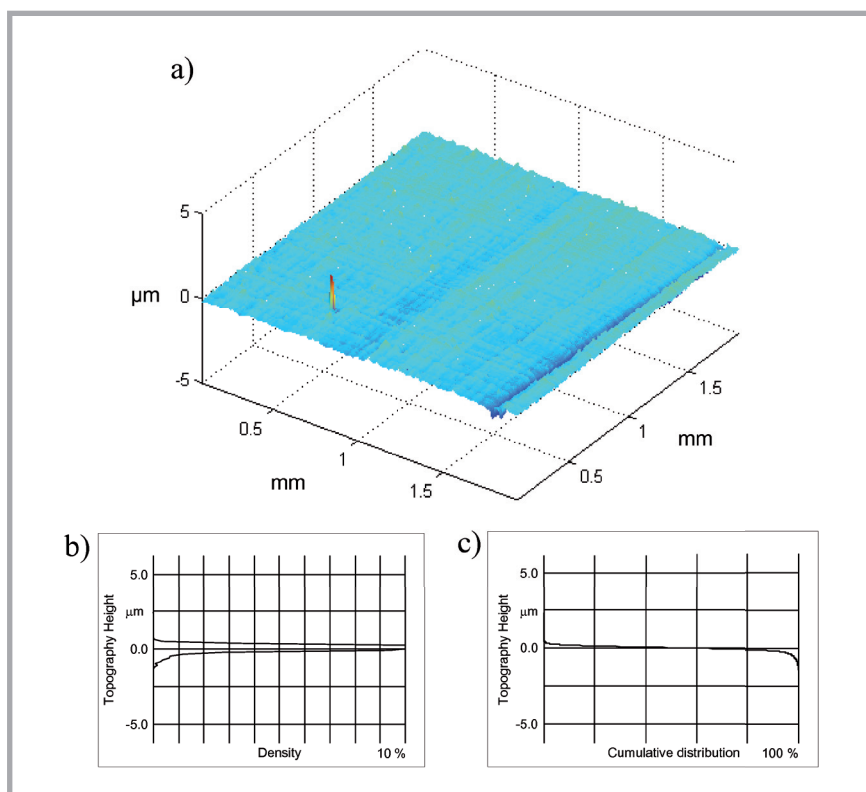


Figure 7. Geometric structure of a 3D surface in the collecting groove, R_{cg} , of a rotor made of alloy EN AW-2024 before operation: $S_q=0.20 \mu\text{m}$, $S_p=1.05 \mu\text{m}$; a) surface topography view, b) surface ordinate distribution curve, c) surface material ratio curve.

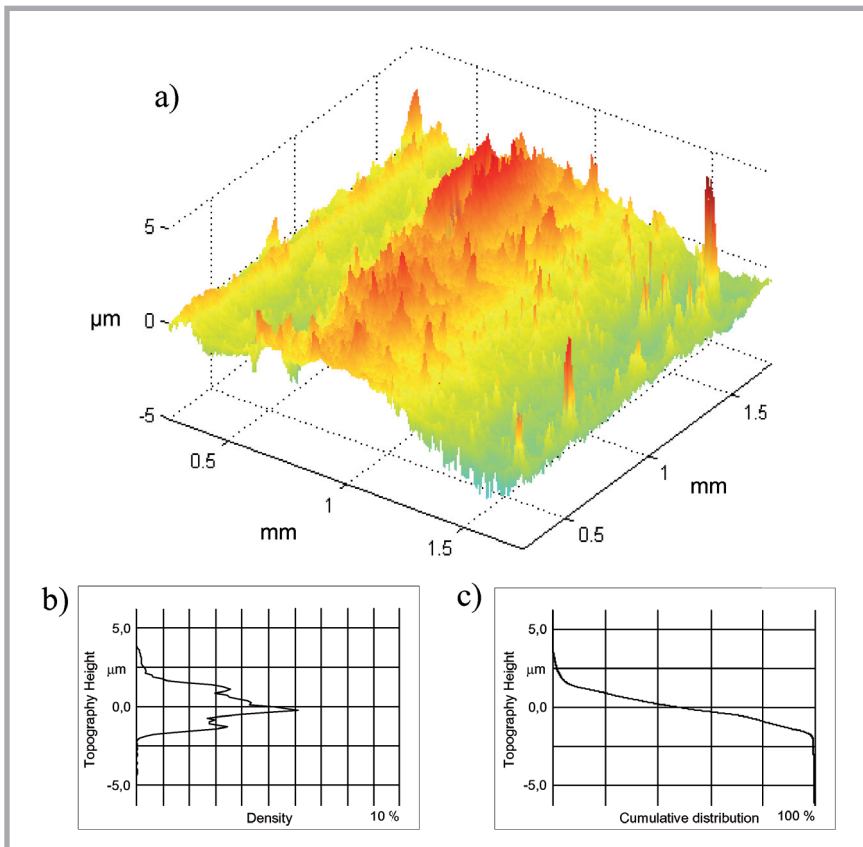


Figure 8. Geometric structure of the 3D surface of the oxide layer in the collecting groove, R_{CG} , a rotor made of alloy EN AW-2024 after an operation period of about 6 000 hours: $S_q=0.87 \mu\text{m}$, $S_p=8.61 \mu\text{m}$; a) surface topography view, b) surface ordinate distribution curve, c) surface material ratio curve.

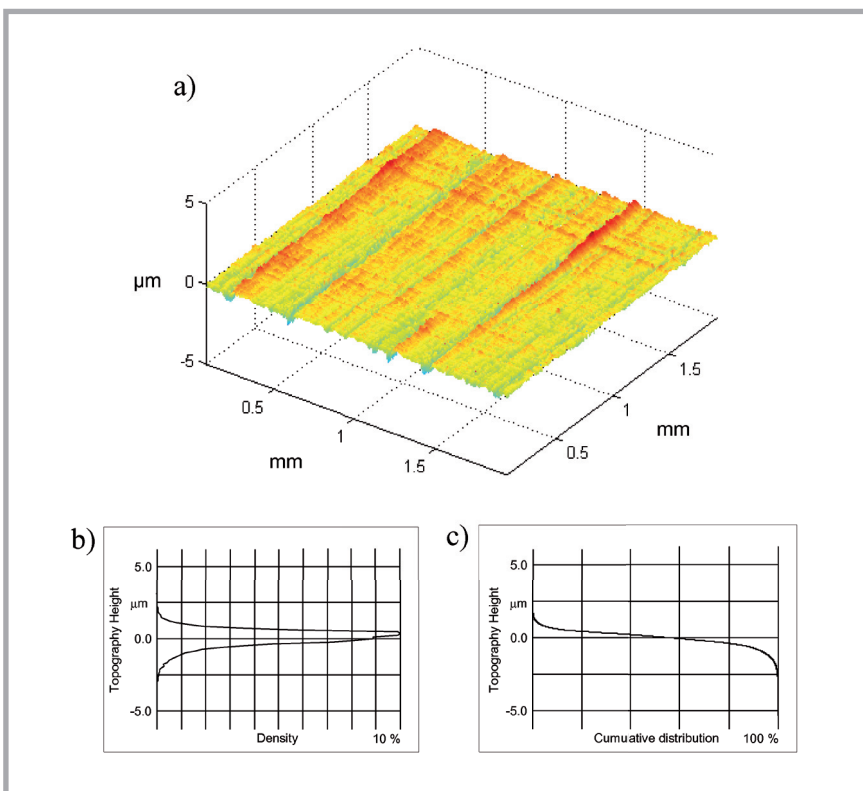


Figure 9. Geometric structure of the 3D surface of the oxide layer in the collecting groove R_{CG} , of a rotor made of alloy EN AW-6082 before operation: $S_q=0.67 \mu\text{m}$, $S_p=1.93 \mu\text{m}$; a) surface topography view, b) surface ordinate distribution curve, c) surface material ratio curve.

fore and after an operation period of about 6000 hours, as well those for rotors made of alloy EN AW-6082 after hard anodic oxidation, before and after a period of operation of about 9000 hours.

The complex characteristics of the 3D geometric structure in the collecting groove of rotors made of alloy EN AW-2024 before and after a period of operation of about 6000 hours are shown in **Figures 7** and **8** (they comprise a view of the surface topography, the curve of the surface topography ordinate distribution, and the material ratio curve). Characteristics of the rotor made of alloy EN AW-6082 after hard anodic oxidation, before and after a period of operation of about 9000 working hours, are shown in **Figures 9** and **10**.

As an example, for rotors made of alloy EN AW-2024 after finishing treatment, the surface roughness of the inner surface inclined at an angle of 50° , of the collecting groove, R_{CG} , was as follows: $S_a = 0.13 \mu\text{m}$, $S_q = 0.20 \mu\text{m}$, $S_p = 1.05 \mu\text{m}$, $S_v = 1.79 \mu\text{m}$, $S_t = 2.84 \mu\text{m}$, $S_k = 0.46 \mu\text{m}$, $S_{pk} = 0.02 \mu\text{m}$, and $S_{vk} = 0.51 \mu\text{m}$. However, after a period of exploitation of about 6000 working hours, a significant increase in surface roughness occurred, i.e. $S_a = 0.67 \mu\text{m}$, $S_q = 0.87 \mu\text{m}$, $S_p = 8.61 \mu\text{m}$, $S_v = 5.87 \mu\text{m}$, $S_t = 14.47 \mu\text{m}$, $S_k = 4.34 \mu\text{m}$, $S_{pk} = 0.08 \mu\text{m}$, and $S_{vk} = 1.25 \mu\text{m}$. As for the rotors made of alloy EN AW-6082, after hard anodic oxidation and grinding with linen and abrasive paper, the surface roughness was as follows: $S_a = 0.46 \mu\text{m}$, $S_q = 0.67 \mu\text{m}$, $S_p = 1.93 \mu\text{m}$, $S_v = 6.09 \mu\text{m}$, $S_t = 8.02 \mu\text{m}$, $S_k = 0.90 \mu\text{m}$, $S_{pk} = 0.03 \mu\text{m}$, and $S_{vk} = 1.66 \mu\text{m}$; after a period of operation of about 9000 working hours there was a slight decrease in such parameters of the oxidised layer: $S_a = 0.39 \mu\text{m}$ and $S_q = 0.64 \mu\text{m}$, and a distinct increase in the remaining parameters: $S_p = 6.28 \mu\text{m}$, $S_v = 8.76 \mu\text{m}$, $S_t = 15.04 \mu\text{m}$, $S_k = 2.41 \mu\text{m}$, $S_{pk} = 0.13 \mu\text{m}$, and $S_{vk} = 3.88 \mu\text{m}$. In the case of rotors made of alloy EN AW-2024 (AlCu4Mg1), the 3D surface topography parameters of the oxidised layers which strongly correlate with the yarn kinetic coefficient of friction, i.e. S_p and S_q [11], and as a result of the operation, significantly increased: parameter S_p 8.2 times and S_q 4.35 times. However, for rotors made of alloy EN AW-6082 subjected to hard anodic oxidation, a period of exploitation of about 9000 working hours causes a rather modest increase in parameter S_p - 3.25, but the value of the roughness parameter S_q is slightly smaller than its value before exploitation.

Microphotography of the surface inclined at an angle of 50° in the collecting groove, R_{cg} , of the rotor made of alloy EN AW-2024 before and after a period of exploitation of about 6000 working hours is shown in **Figure 11**. The rotor made of alloy EN AW-6082 after hard anodic oxidation and grinding, before and after a period of operation of about 9000 hours, can be seen in **Figure 12**. The surface, inclined at an angle of 50° , of the collecting groove of the rotor not subjected to hard anodic oxidation is characterised by slight roughness (slight traces after the operation of grinding and polishing - **Figure 11.a**). During the operation of the spinning machine, the yarn and impurities in the collecting groove are pressed to its inner surface by the centrifugal and Coriolis forces, generating intensive wear action.

According to the author, wear occurs due to the grooving process, which is in the form of numerous cavities of a width of several to a dozen micrometers. As a result, an eight-fold increase in the maximum peak heights of the surface S_p occurs along with a five-fold increase in the maximum height of the surface topography S_t . An extended period of exploitation of up to about 6000 working hours causes the elimination of significant volumes of material from the entire periphery of the rotor (**Figure 3.d**), and in critical cases 'cracks' are generated in the collecting groove (**Figure 3.b**). The operation of hard anodic oxidation causes a significant increase in the surface roughness. The traces of machining are presented (**Figure 12.a**). As a result of the initial period of the operation, smoothening of the surface roughness occurs. As the period of operation prolongs, intensive abrasion of the oxide layer occurs, and on the friction surface wear debris in the form of loose solid particles appears, as well as cavities and craters (**Figure 12.b**).

The roughness height of the oxide layer shows a clear increase. For example, there is a three times bigger increase in the maximum peak height of surface S_p and about a 1.88 times bigger increase in the maximum surface topography height S_t . It can be stated that a significant increase in the micro hardness of the surface layer in the collecting groove, R_{cg} , of rotors causes a considerable decrease in the wear intensity, which is manifested in the lower intensity of the increase in surface roughness. Consequently, after the period of exploitation of about 9000 working hours, a total removal of the oxide layer of about $50 \mu\text{m}$

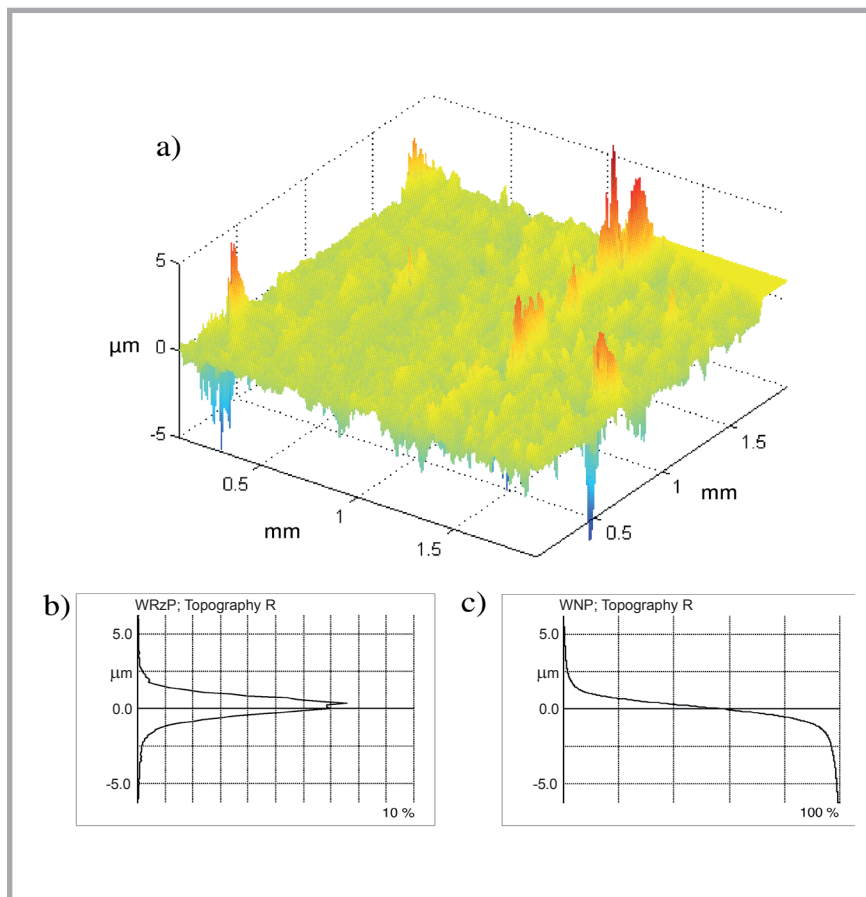


Figure 10. Geometric structure of the 3D surface of the oxide layer in the collecting groove, R_{cg} , of a rotor made of alloy EN AW-6082 after an operation period of about 9000 hours: $S_q=0.64 \mu\text{m}$, $S_p=6.28 \mu\text{m}$; a) surface topography view, b) surface ordinate distribution curve, c) surface material ratio curve.

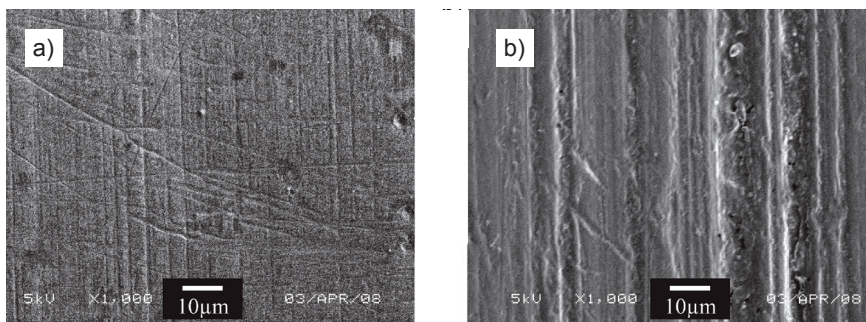


Figure 11. Microphotography of the surface inclined at an angle of 50° in the collecting groove, R_{cg} , of a rotor made of alloy EN AW-2024, (magnification $1000\times$): a) before operation; b) after a period of operation of about 6000 hours.

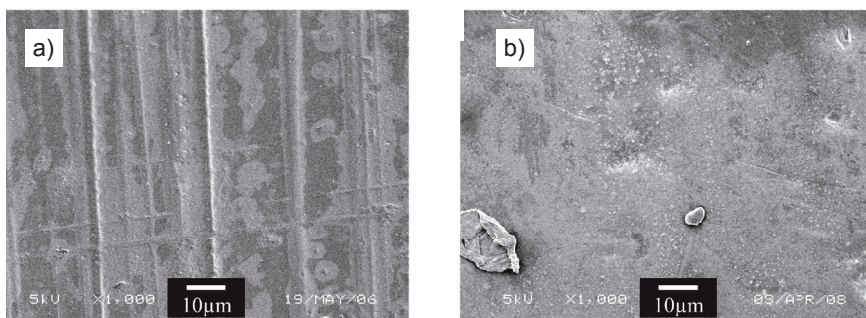


Figure 12. Microphotography of the oxide surface layer inclined at an angle of 50° in the collecting groove, R_{cg} , of rotors made of alloy EN AW-6082, (magnification $1000\times$): a) before operation; b) after a period of operation of about 9000 working hours.

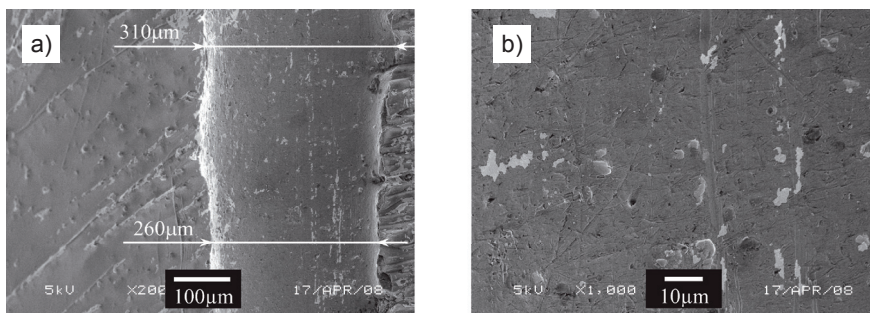


Figure 13. Microphotography of the surface wear in the collecting groove R_{cg} of a rotor made of alloy EN AW-6082 after a period of operation of about 9000 hours: a) wear of the oxide layer in the form of a cavity, magnification 200 \times ; b) wear surface at the bottom of the cavity, magnification 1000 \times .

thickness and that of the substrate layer of about 60 μm thickness occur on a surface of about 260 to 310 μm width over the entire periphery of the rotor (**Figure 13.a**). Wear in the form of a groove of variable width on the rotor periphery is not placed at the point of the largest inner diameter but is slightly displaced towards the conical surface, inclined at an angle of 50°. This is explained by the direction of the resulting two forces, i.e. the centrifugal and Coriolis, which act on the moving yarn and impurities pressed to the collecting groove surface with an intensive wear action.

Conclusions

In the case of open end spinning machines, the application of hard anodic oxidation to rotors made of alloy EN AW-6082 caused about a 2.5 times higher increase in rotor durability compared to the durability of rotors made of alloy EN AW-2024 not subjected to anodic oxidation, which can be explained by the 5 times higher increase in the micro hardness of the oxide layer when compared to the micro hardness of the surface layer in an anodic non-oxidised collecting groove. The investigations have shown that with the proper selection of materials, rotors after anodic oxidation with a proper surface topography and high hardness can be manufactured. Such rotors assure better operational properties and, in particular, a lower friction coefficient, which also allows to obtain better quality yarn with a significant increase in wear resistance. After a period of exploitation of about 6000 hours, exemplary wear in the collecting groove without an oxide layer ranged between 2.5 up and 3.0 mm at a wear intensity of 0.420 - 0.500 $\mu\text{m}/\text{h}$. However, after hard anodic oxidation, the wear in the collecting groove after a period of exploitation of about 9000 hours reached a

maximum value of 0.105 - 0.110 mm at a wear intensity of 0.0117 - 0.0122 $\mu\text{m}/\text{h}$.

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UNIVERSITY OF BIELSKO-BIAŁA

Faculty of Textile Engineering and Environmental Protection

The Faculty was founded in 1969 as the Faculty of Textile Engineering of the Technical University of Łódź, Branch in Bielsko-Biała. It offers several courses for a Bachelor of Science degree and a Master of Science degree in the field of Textile Engineering and Environmental Engineering and Protection.

The Faculty considers modern trends in science and technology as well as the current needs of regional and national industries. At present, the Faculty consists of:

- The Institute of Textile Engineering and Polymer Materials, divided into the following Departments:
 - Polymer Materials
 - Physics and Structural Research
 - Textile Engineering and Commodity
 - Textile Engineering and Commodity
 - Applied Informatics
- The Institute of Engineering and Environmental Protection, divided into the following Departments:
 - Biology and Environmental Chemistry
 - Hydrology and Water Engineering
 - Ecology and Applied Microbiology
 - Sustainable Development
 - Processes and Environmental Technology
 - Air Pollution Control



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