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THE CORRELATION BETWEEN MICROSTRUCTURE, MECHANICAL AND TRIBOLOGICAL PROPERTIES IN THE ALLOYS OF Co-Cr PROTECTORS WITH MICRO ADDITIVES Mo AND W

KORELACJA POMIĘDZY MIKROSTRUKTURĄ, WŁAŚCIWOŚCIAMI MECHANICZNYMI I TRIBOLOGICZNYMI STOPÓW PROTETYCZNYCH Z UKŁADU Co-Cr Z MIKRODODATKAMI Mo I W

Key words: Co-Cr alloys, wear, microstructure, dendrite crystallization.

Abstract: The paper presents the results of tests of tribological wear of two Co-Cr-Mo alloys (Wironit LA) and Co-Cr-Mo-W (Colado CC) used to make skeletal prostheses, combined works, implants and metal frameworks for ceramics. The test samples were centrifugally cast using the lost wax method and subjected to hardness measurements, microscopic observations, and a quantitative description of the microstructure. SEM examinations and EDS analysis of micro-areas on dendritic arms and interdendritic areas were performed together. The abrasive wear resistance tests with the use of a T-05 tester in the friction system roller-block were conducted in a dry sliding contact under the conditions of a metal-metal contact with the load of 100 N and for two friction paths, 500 and 1000 m.

Słowa kluczowe: stopy Co-Cr, zużycie tribologiczne, mikrostruktura, krystalizacja dendrytyczna.

Streszczenie: W pracy przedstawiono wyniki badań zużycia tribologicznego dwóch stopów Co-Cr-Mo (Wironit LA) i Co-Cr-Mo-W (Colado CC) stosowanych do wykonywania protez szkieletowych, prac kombinowanych, implantów i szkieletów metalowych pod ceramikę. Badane próbki odlewano odśrodkowo metodą wosku traconego i poddawano pomiarom twardości, obserwacjom mikroskopowym wraz z ilościowym opisem mikrostruktury. Wykonano badania SEM wraz z analizą EDS mikroobszarów na ramionach dendrytycznych oraz obszarów interdendrytycznych. Badania odporności na zużycie ścierne z wykorzystaniem testera T-05 w układzie ciernym wałek–blok przeprowadzono w suchym styku ślizgowym w warunkach kontaktu metal–metal z obciążeniem 100 N i dla dwóch dróg tarcia, 500 i 1000 m.

INTRODUCTION

Human dentition is a very characteristic "system" which, to a large degree, is exposed to various processes capable of causing mechanical, such as: cracking, breaking or chipping **[L. 1]**. A mechanical to a metal denture can occur during normal eating habits due to biting something hard, like a nut or a fork, or due to poor anatomy of the patient's occlusion **[L. 2, 3]**.

Because of the high loads occurring under the conditions of chewing, the metallic materials applied in prosthetics should be characterised by good mechanical properties **[L. 4–6]**, the facility to obtain even complicated shapes, as well as good tribological properties **[L. 7–11]**, and, of course, also exhibit high biocompatibility **[L. 12, 13]**. The tribological tests reflecting the working environment of such materials are usually types of experiments involving the effect of other physical factors which

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can disturb the end result. The study **[L. 14]** presents the results of investigations of the abrasive wear of Co-Cr-Mo and Co-Cr-Mo-W alloys were obtained by the lost wax method. The abrasion tests were performed with the use of the Miller apparatus in a mixture of SiC powder and artificial saliva. The abrasion process included the cycles of 2, 4, 6, 8, 12 and 16 hours.

The performed tests revealed that the examined alloys were characterised by a small degree of hardness anisotropy in three selected perpendicular directions in respect of the casting direction. The obtained hardness values were within the scope of 397-444 HV10. It was stated that the lowest mass loss value was recorded for the alloy Remanium 2001 (Co-Cr-Mo-W) and Wironit LA (Co-Cr-Mo). In the case of alloy Remanium 2001, a linear character of the relative mass loss drop curve related to time was observed practically for the whole abrasion time scope, whereas, for alloy Wironit LA, a significant deviation from rectilinearity in the scope of 8–16 hours was recorded. It should be emphasised that the abrasion process conducted in **[L. 14]** was long and time-consuming.

For this reason, while planning the new experiment, an attempt was made to apply a different metal-metal friction system with the use of a counter-sample made of bearing steel (100Cr6). Using a different friction system aimed at shortening the experiment time and reducing the effect of other factors on the result of the tribological tests, thus enabling a focus on the material's microstructure.

It should be noted that the groups of alloys which are most frequently used for prosthetic restorations are alloys from the CoCr group with microadditions Mo and/or W **[L. 15]**. Co-Cr-Mo alloys are applied in the construction of skeletal prostheses, clamps, locks or other retention elements. Besides their thermal expansion, similar to ceramic materials, Co-Cr-W-Mo alloys are also characterised by a thinner passive layer **[L. 1, 2]**. They are used mostly for burning ceramics directly on the metal or for acrylate coating. They are applied to make skeletal constructions, crowns and bridges **[L. 3]**.

One of the methods of obtaining retention elements is the lost wax method, also called cire-perdue. The method allows for restorations with complicated shapes characterised by a thin cast wall. Unfortunately, these materials have a dendritic structure typical of casting materials, with strong chemical segregation in the dendritic arms and the adjoining areas, i.e., the so-called interdendritic spaces, in which, during crystallisation, carbide phases type $M_{23}C_6$, MC, or M_2C are locally formed. **[L. 17–19]**. The carbide phases reinforce the alloy, thus increasing its hardness and strength **[L. 20, 21]**.

The authors of the presented research carried out an analysis of the effect of the carbide phases' dispersion, their distribution in the alloy and the distance between them on the tribological wear of the examined commercial alloys Wironit LA (Co-Cr-Mo) and Colado CC (Co-Cr-W-Mo). The examinations of the tribological wear were conducted in a roll-block friction system. The experiment performed, and the knowledge gained on the correlation between the microstructure of the studied CoCr alloys and tribological wear will potentially increase the prosthetic component's durability. It was found that the abrasive wear resistance of the tested materials is related to the geometric nature of the material's microstructure after the solidification process, and thus the volume share, dispersion and shape of the resulting carbide phase separations in the tested alloys.

MATERIALS AND RESEARCH METHODOLOGY

The study subjects were Co-Cr alloys used to make skeletal prostheses, retention components, implants and metal frameworks for ceramics. The chemical compositions of the alloys Co-Cr-Mo (commercial name Wironit LA) and Co-Cr-Mo-W (commercial name Colado CC) have been presented in **Table 1**.

Table 1. Chemical composition of tested Co-Cr alloys
Tabela 1. Skład chemiczny badanych stopów Co-Cr

Name of the alloy	Element, (% mas.)								
	Cr	Mo	W	Si	Nb	Ga	Fe	C	Co
Wironit LA	32.4	4.83	–	–	–	–	–	0.24	rest
Colado CC	23.7	5.51	5.50	0.83	0.18	3.87	0.34	0.03	rest

The test samples were centrifugally cast by means of the lost wax method. The first stage of the casting process was the preparation of the wax models of specified dimensions for each alloy: 20×4×4 mm (dimensions of the samples required for abrasive tests with the use of a T-05 tester in a friction system roller-block). Next, the wax models were placed in a ring filled with refractory mass based on phosphates. After the casting, the rings were placed in a pressure chamber, with the pressure set to 0.4 MPa for 20 minutes, for proper binding of the refractory mass. After the mass had been bound, the formed crucible was placed into a furnace, and the process of annealing began at the rate of 7°C/min.

During the annealing, two isothermal stops were made: the first one at the temperature of 250°C, for the time of 20 minutes, in order for the water to vaporise from the casting ring and for the wax to evaporate, and the second one at the temperature of 600°C, when a transformation of the silica occurs. The end of the remelting process took place at the temperature of 950°C/20 min, and next, the casting process with the use of a Vulcan 3-550 furnace began. After the casting, the samples were removed from the furnace and cooled in the open air. The following stage of the experiments was removing the refractory mass and mechanical sandblasting on an Ecoblast Kombi machine with the use of 200 μm granularity sand and applying 0.6 MPa pressure. The last step of sample preparation was the mechanical removal of the gating channels.

The measurement of the samples was performed by the Vickers method. The hardness was examined on a ZWICK/ZHU 187.5 hardness tester with a 98.7 N (HV10) load. The number of measurements was 10, performed in randomly selected sample areas.

In order to reveal the microstructure of the examined Co-Cr alloys, the microsections were subjected to chemical etching, with the use of the following etching reagent: 1 portion of HNO_3 + 3 portions of HCl. The microsections prepared this way were subjected to observations using a HITACHI S-3500N scanning electron microscope with an X-ray energy-dispersive spectroscopy detector with an EDS attachment – NORAN 986B-1SPS. The accelerating voltage of 20 kV used in SEM-EDS observation and analysis was adopted for the simulation. In the microstructure images taken with the magnification of 500x through the computer image analysis MetIlo software, measurements were made of the size of the interdendritic areas and the free distance between them. Also, the percentage volume fraction of the interdendritic areas in the examined Co-Cr alloys was estimated.

The abrasive wear resistance tests with the use of a T-05 tester in the friction system roller-block were conducted in a dry sliding contact under the conditions of a metal-metal contact with the load of 100 N and for two friction paths, 500 and 1000 m. The counter specimen was a φ 49.5 mm ring made of steel 100Cr6 with a hardness of 55 HRC. The spindle worked with 136 rpm. The surfaces of the examined samples after abrasion underwent profilometric tests performed with the use of an optical profilometer WYKO NT9300. The average wear depth was assessed from ten cross-sections obtained during profilometric tests. Mechanical properties were evaluated by measuring the hardness of the sample's surface using the Vickers method under a load of 10 kG (98.1 N).

THE RESULTS OF THE RESEARCH

Roughness plays an important role in the tribological process. However, the test method used (tribotester T-05), and the process parameters mean that the initial stage of wear, in which roughness plays a significant role, is followed by a subsequent stage in which the two surfaces are already working together. As a result, the initial roughness of the sample is no longer important. Therefore, the paper focuses on the effects visible after the friction tests are performed and the influence of the alloy's microstructure on the wear test results. The initial stage of the research involved tribological tests on prepared ingots. The test specimens were cleaned with an ultrasonic cleaner. Surfaces that were tested were ground using sandpaper with a gradation of 220. The grinding was carried out in a direction parallel to the axis of the sample. A summary of the tribological tests and wear surface hardness is shown in **Table 2**.

The results of the friction tests for the friction path equalling 500 m are similar for both alloys from the Co-Cr system. A slightly lower mass loss is observed for the alloy Colado CC (Co-Cr-Mo-W). At the same time, we can observe a higher mean abrasion depth for this alloy, yet the difference in the case of both examined alloys is small. In the case of the friction path of 1000 m, lower wear was observed in the case of alloy Wironit LA (Co-Cr-Mo).

Table 2. Tribological test results for the investigated alloys Co-Cr
Tabela 2. Wyniki badań tribologicznych dla badanych stopów Co-Cr

ID	Path	Δm	Average depth of the wear area	Average Friction Coefficient	Hardness
Unit	m	mg	µm	_	HV10
Wironit LA (Co-Cr-Mo)	500	3.57	55.76	0.33	450 ± 10
	1000	6.33	89.66	0.34	434 ± 10
Colado CC (Co-Cr-Mo-W)	500	3.29	59.00	0.31	405 ± 10
	1000	8.28	107.70	0.33	395 ± 10

The volumetric wear of the material assessed by the depth of the formed abrasion is also similar for both tested alloys in the case of the friction path equalling 500 m. The increased friction path length resulted in an increase in the mean depth of the abrasion formed on the sample's surface. Just like in the case of the mass wear and the abrasion depth analysis, alloy Wironit LA exhibits lower wear than alloy Colado CC. The friction coefficient for all the analysed alloys and variants remains at a similar level. A slightly lower value of this parameter is observed for alloy Co-Cr-Mo-W. The analysis of the hardness changes of the examined alloys shows that alloy Wironit LA characterises a bit higher hardness value than alloy Colado CC (**Tab. 2**).

The following stage of studies was an analysis of the worn surface with the use of a scanning electron microscope (SEM). The images of the worn surfaces for the analysed samples are shown in **Figure 1**. The performed analysis made it

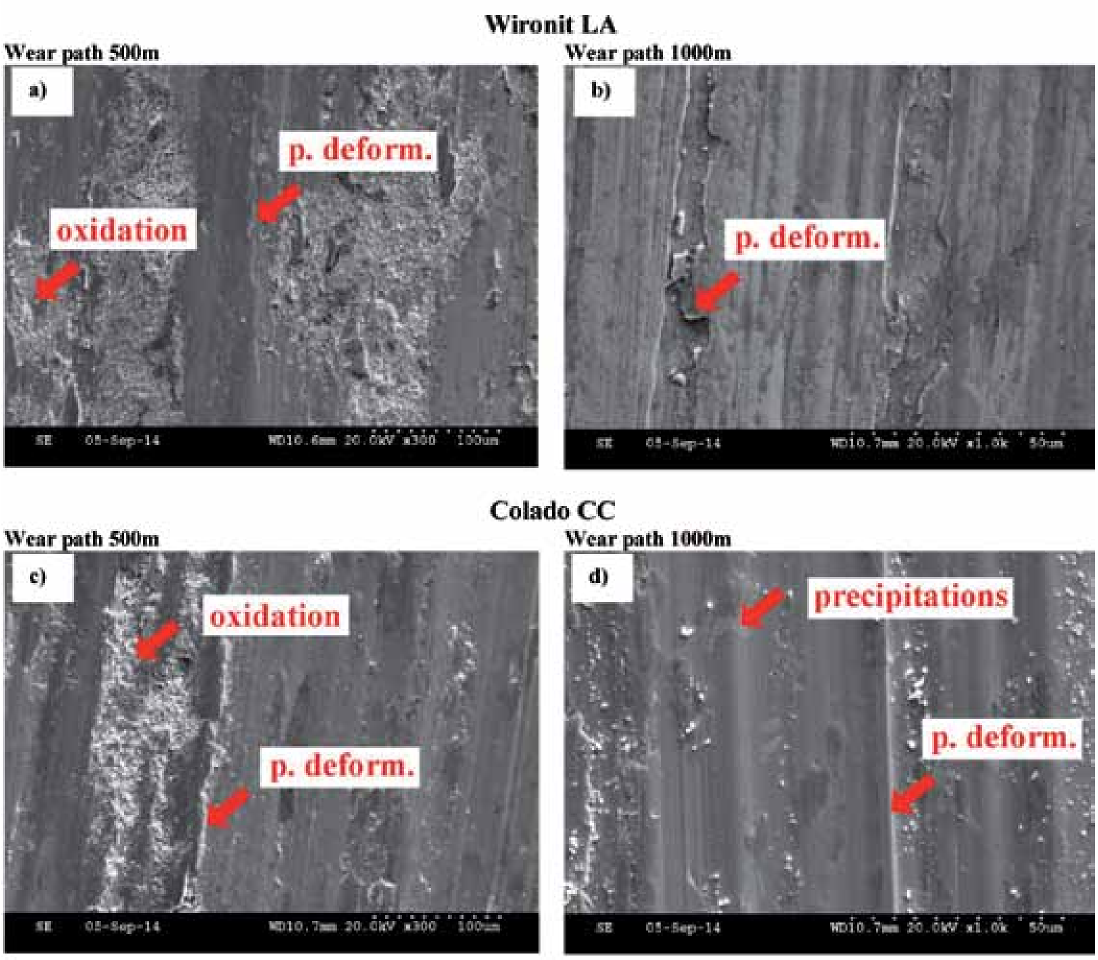


Fig. 1. Examples of SEM images of the worn surfaces of the tested Wironit LA alloys (Co-Cr-Mo) (a, b) and Colado CC (Co-Cr-Mo-W) (c, d) subjected to abrasion with a T-05 roll-block tester
Rys. 1. Przykładowe obrazy SEM zużytych powierzchni badanych stopów Wironit LA (Co-Cr-Mo) (a, b) i Colado CC (Co-Cr--Mo-W) (c, d) poddanych procesowi ścierania testerem typu rolka–klocek T-05

possible to document a similar tribological wear mechanism at the surface of both tested alloys. The main wear mechanisms were microwedging. We can observe a certain participation of plastic deformation of the examined material's surface during wear. Thus, we can suppose that, to some degree, for the tested alloys, microplowing took place as well. More intensive plastic deformation is observed for the friction path of 1000 m (**Fig. 1c, d**). Additionally, each material demonstrates a tendency for oxidation as a result of the tribological activity. This is especially visible for the friction path equalling 500 m (**Fig. 1a, c**). In the case of a longer friction path, i.e., 1000 m, the oxidation products on the samples' surfaces are less clearly visible. For alloy Colado CC, we observe characteristic interdendritic precipitations on the friction face in the abraded area (**Fig. 1d**).

Next, in order to document the material's microstructure, microsections were prepared in the cross-section to the surface of the formed abrasion. The images of the tested alloys' microstructures are shown in **Figure 2**. In the case of both examined materials, we can observe a characteristic dendritic microstructure. We can see interdendritic precipitates clearly separated from the matrix. The microstructure of the alloy Colado CC (**Fig. 2c, d**) is more refined than that of Wironit LA (**Fig. 2a, b**).

In the subsequent stage of research, a quantitative evaluation was made of the stereological parameters, such as the volume fraction of the interdendritic precipitates (Vv, %), the surface area of the particles (a, μm^2), the distance between the interdendritic spaces (λ, μm) and the shape factor **[L. 22, 23]**. For the evaluation of the numerical parameters describing the interdendritic

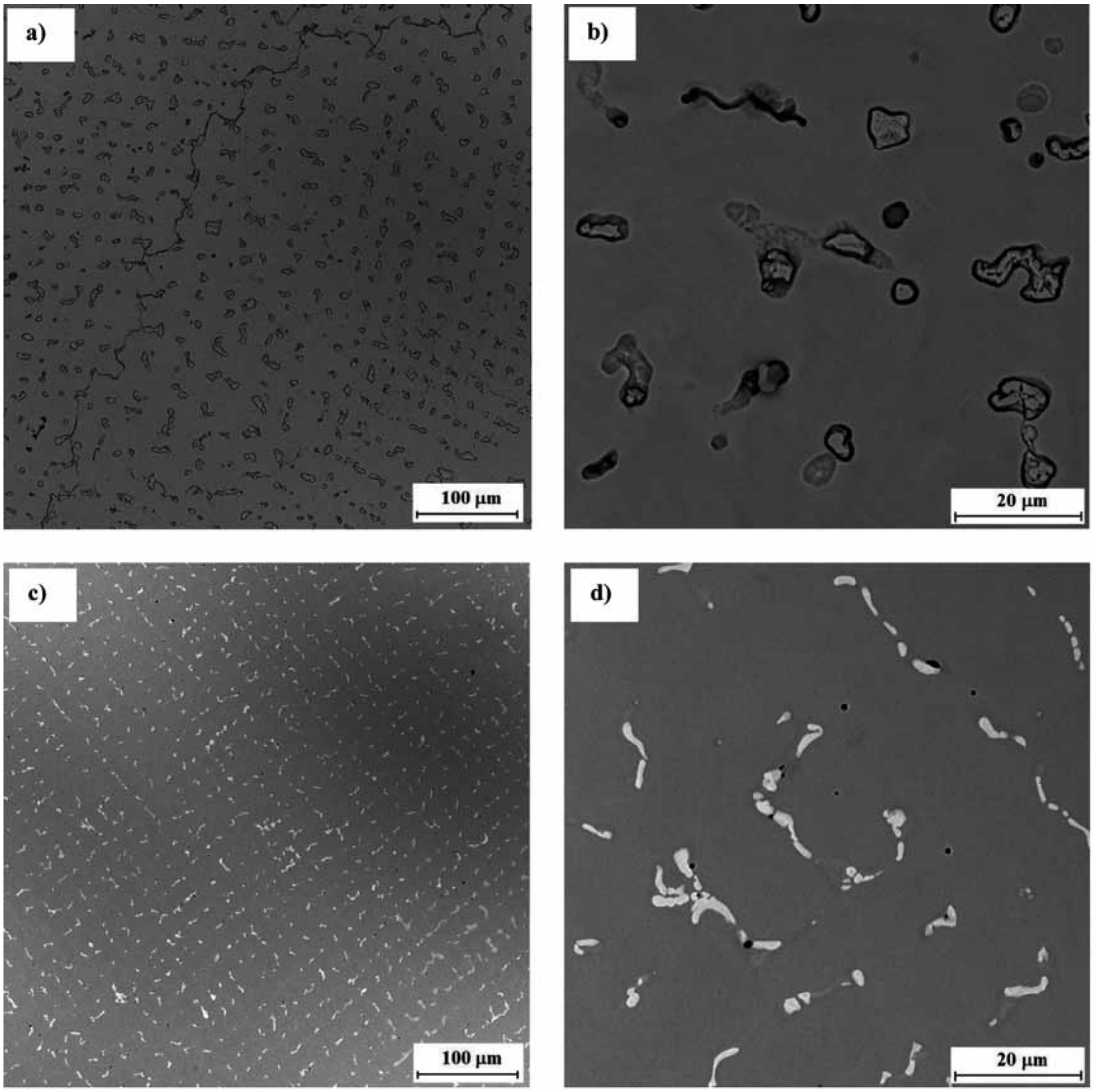
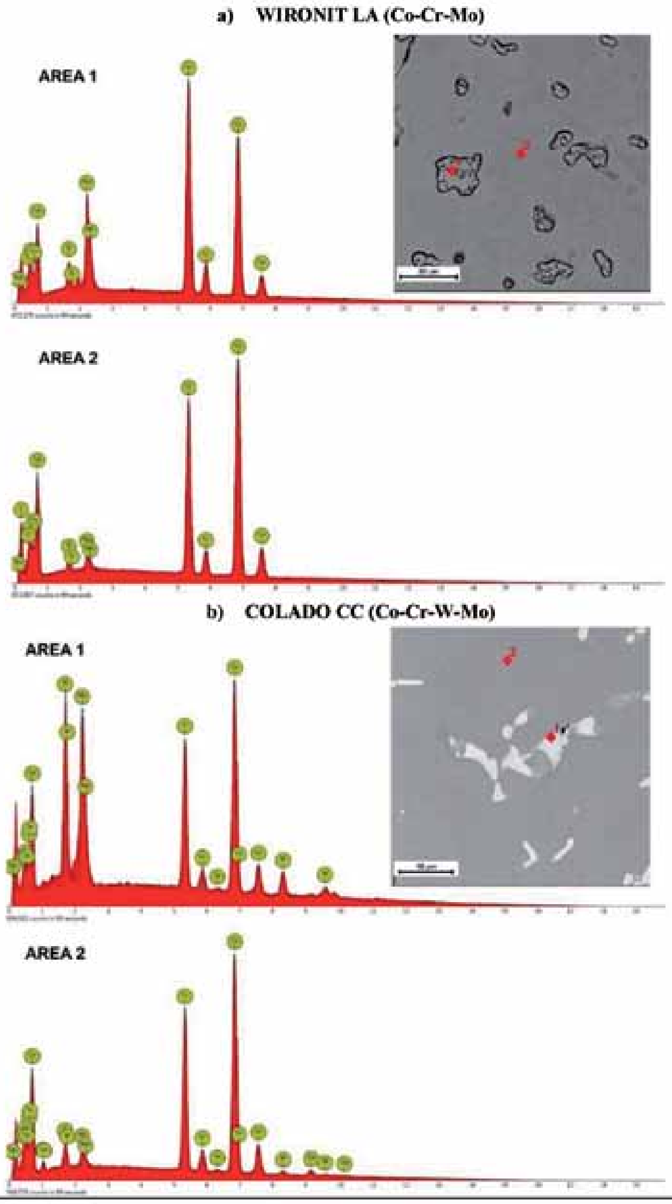


Fig. 2. Microstructures of the alloys studied: Co-Cr-Mo (Wironite LA) (a, b) and Co-Cr-Mo-W Colado CC (c, d)
Rys. 2. Mikrostruktury badanych stopów: Co-Cr-Mo (Wironit LA) (a, b) i Co-Cr-Mo-W Colado CC (c, d)

Table 3. Stereological (quantitative) parameters of the microstructure of the studied Co-Cr alloys
Tabela 3. Parametry stereologiczne (ilościowe) mikrostruktury badanych stopów Co-Cr

Investigated material	Vv, %	a, μm^2	λ, μm	Shape factor
Wironit LA (Co-Cr-Mo)	7.2 ± 2.5	43.2 ± 34.5	9.8 ± 4.9	0.81 ± 0.19
Colado CC (Co-Cr-Mo-W)	13.3 ± 5.7	130.9 ± 76.0	12.9 ± 6.1	0.51 ± 0.22



Area	Chemical composition, mass %							
	Wironit LA				Colado CC			
	Co	Cr	Mo	Si	Co	Cr	Mo	W
1	43.9	32.2	21.4	2.4	30.3	12.8	26.6	30.1
2	66.2	27.5	4.9	1.3	59.2	23.5	4.9	8.3

Fig. 3. SEM images of Wironite LA (Co-Cr-Mo) (a) and Colado CC (Co-Cr-W-Mo) (b) alloys with EDS analysis of areas and X-ray spectra
Rys. 3. Obrazy SEM stopów Wironit LA (Co-Cr-Mo) (a) oraz Colado CC (Co-Cr-W-Mo) (b) wraz z analizą EDS oznaczonych obszarów i widmami rentgenowskimi

precipitates observed in the material, the MetIlo software was used **[L. 23–25]**. The obtained investigation results have been included in **Table 3**.

The performed quantitative analysis of the precipitates present in the examined Co-Cr alloys shows that alloy Wironit LA (Co-Cr-Mo) is characterised in a smaller volume fraction of interdendritic precipitates than alloy Colado CC (Co-Cr-W-Mo) (**Tab. 3**). Additionally, we can observe a smaller mean particle area for this material (**Tab. 3**). Also, the mean distance between the interdendritic precipitates is much smaller than in the case of alloy Colado CC (**Tab. 3**). While analysing the differences in the values of the mean shape factor, we can state that, in the case of alloy Wironit LA, the particles are close to spherical (**Tab. 3**). This is concluded based on the shape factor value, which equals 0.81 ± 0.19 (Shape factor of the circle = 1) (**Tab. 3**),

As a consequence of the obtained test results, an analysis was carried out of the chemical composition of the precipitates observed in the tests. The chemical composition analysis was made by means of the EDS method, which made it possible to observe that the precipitates present in the alloy Wironit LA (Co-Cr-Mo) are enriched with Cr and Mo. Segregation into the areas between the dendritic arms (interdendritic spaces) is undergone by Mo, whose content in this micro test area is over five times higher than in the alloy's matrix (**Fig. 3a**). The content of Cr in the areas between the dendritic arms is higher by about 17% (**Fig. 3**). We can conclude that the precipitates present between the interdendritic spaces are carbide phases type MC, M_2C and $M_{23}C_6$ rich in Mo and Cr. Similar results are observed in the case of Colado CC, where, in the precipitate area (interdendritic space), we observe a significant enrichment with Mo and W. Just like in the case of alloy Wironit LA, the molybdenum content in the examined micro areas is five times higher than in the area beyond the precipitate (alloy matrix). Additionally, we can observe an over three-fold increase in the precipitates' tungsten content. Compared to the alloy Wironit LA (Co-Cr-Mo), the interdendritic space characterises a lower Cr content in respect of the matrix. Similarly to the case of the previous alloy, we can suppose that, in the interdendritic spaces, there are precipitates of carbide phases containing Mo and W (**Fig. 3**).

DISCUSSION

In the case of both examined alloys, i.e., Wironit LA (Co-Cr-Mo) and Colado CC (Co-Cr-W-Mo), we observe a dendritic morphology of the microstructure, characteristic of a cast state. The interdendritic growth is connected with a certain degree of material overcooling, both in the aspect of temperature and the so-called concentration supercooling, which promotes the growth of new crystals in energetically advantageous directions. Additionally, the limited diffusion of elements, especially heavy elements such as the analysed Mo and W, strongly segregates these elements into interdendritic spaces. The dendritic segregation of the elements is observed as precipitates of the carbide phases present in the alloy. In the case of examining similar alloys, these precipitates were classified as alloy carbides (Cr, Mo)C and (Cr, Mo, W)C for alloys Wironit LA and Colado C, respectively. The matrix of the tested alloys is constituted by a solution β-Co **[L. 16, 17, 19]**. While comparing the chemical composition of the matrices of both materials, we can observe that they are similar, especially in respect of the Cr content. In the case of alloy Colado CC, we additionally observe a certain content of W in the chemical composition of the matrix (**Fig. 3**). The EDS analysis performed in micro areas on the samples does not, however, make it possible to unequivocally determine the carbon content, which, in turn, made impossible a verification of the assumptions about the presence of carbide phases in the examined alloys. For this reason, we can state that the precipitates present in the tested alloys are probably carbide phases type MC, M_2C and $M_{23}C_6$. These precipitates constitute a reinforcing phase, which translates to the analysed tribological properties of the tested materials.

While comparing both analysed materials, we can observe that the alloy Co-Cr-Mo (Wironit LA) is characterised by a higher hardness (**Tab. 2**) than that of alloy Co-Cr-W-Mo (Colado CC). The observed difference in the hardness values of the examined materials can be referred to as the observed differences in the stereological parameters of the precipitates present in the material. A compilation of the mean measurement results for the Co-Cr alloys has been presented in **Figure 4**.

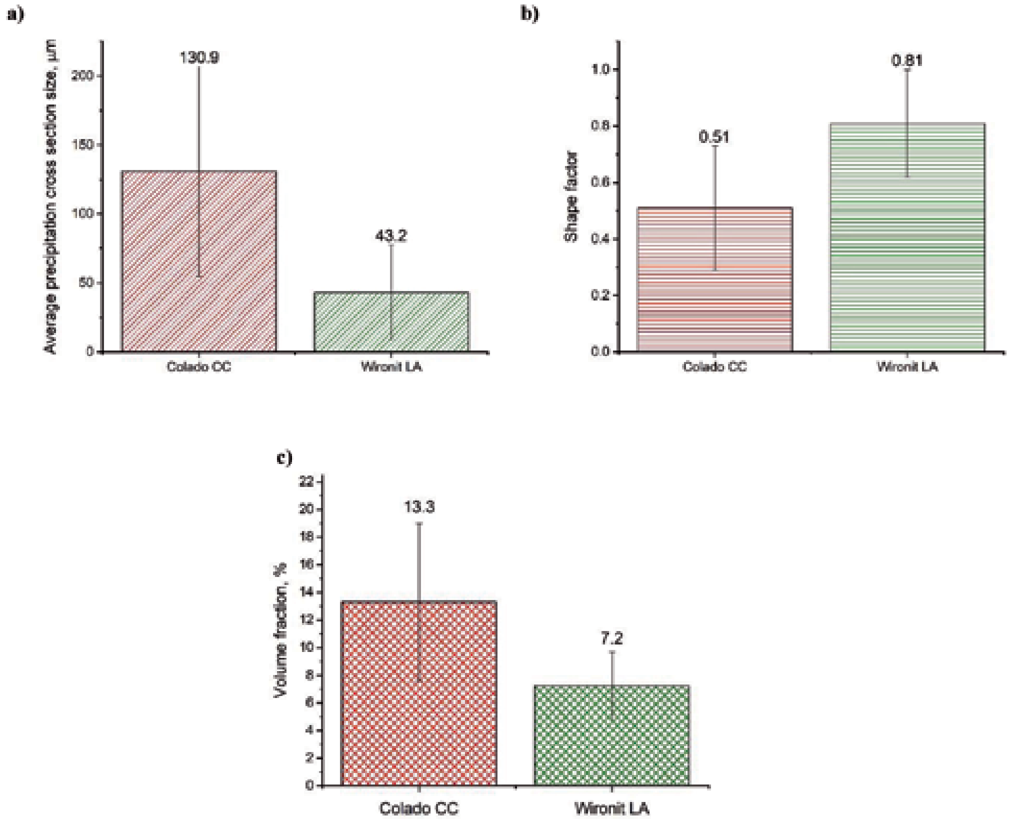


Fig. 4. Summary of the results of stereological measurements for the precipitates observed in the studied Co-Cr alloys; (a) particle cross-sectional area and volume proportion, (b) aspect ratio of the studied precipitates, (c) volume fraction of interdendritic precipitations

Rys. 4. Zestawienie wyników pomiarów stereologicznych dla wydzieleń obserwowanych w badanych stopach Co-Cr; a) pole przekroju cząstki i udział objętościowy, b) współczynnik kształtu badanych wydzieleń, c) udział objętościowy wydzieleń międzydendrytycznych

While analysing the obtained test results, it was expected that alloy Colado CC would be the one to be characterised with a higher hardness due to its higher volume fraction (Vv, %) of interdendritic precipitates (**Tab. 3**) as well as a richer chemical composition. However, while comparing these materials, we should note the other quantitative parameters describing their microstructure. In the case of alloy Wironit LA, the precipitates observed in the material have a morphology similar to spherical. The mean distance between the precipitates is smaller, influencing the effective material reinforcement and translating to the hardness measurement results. The interdendritic precipitates visible in the microstructure of alloy Co-Cr-Mo (Wironit LA) have a smaller surface area, which makes it possible to suppose that, in the case of this alloy, we observe a large number of spherical particles densely packed in the material's matrix. This phenomenon can effectively reinforce the examined alloy. In the case of alloy Co-Cr-W-Mo (Colado CC), we can observe particles of a more irregular and diversified shape, which translates to a lower mean shape factor value of the identified precipitates (**Tab. 3**). In consequence, despite the higher volume fraction of interdendritic precipitates (**Tab. 3**), the material characterises in non-uniformly distributed precipitates in the alloy, between which there is significant participation of the matrix composed of solution β-Co. As a result, this translates to a lower hardness of alloy Colado CC (**Tab. 2**). The shape of the precipitates can be explained by a higher content of elements like Mo and W, where the hindered diffusion of these elements caused a more complex shape of the precipitates (**Tab. 3**, **Fig. 4**).

The tribological test results are presented in **Figure 5**. It compiles the trial results for the samples' mass loss after the test and the volumetric wear expressed by the depth of the formed abrasion (**Fig. 5**).

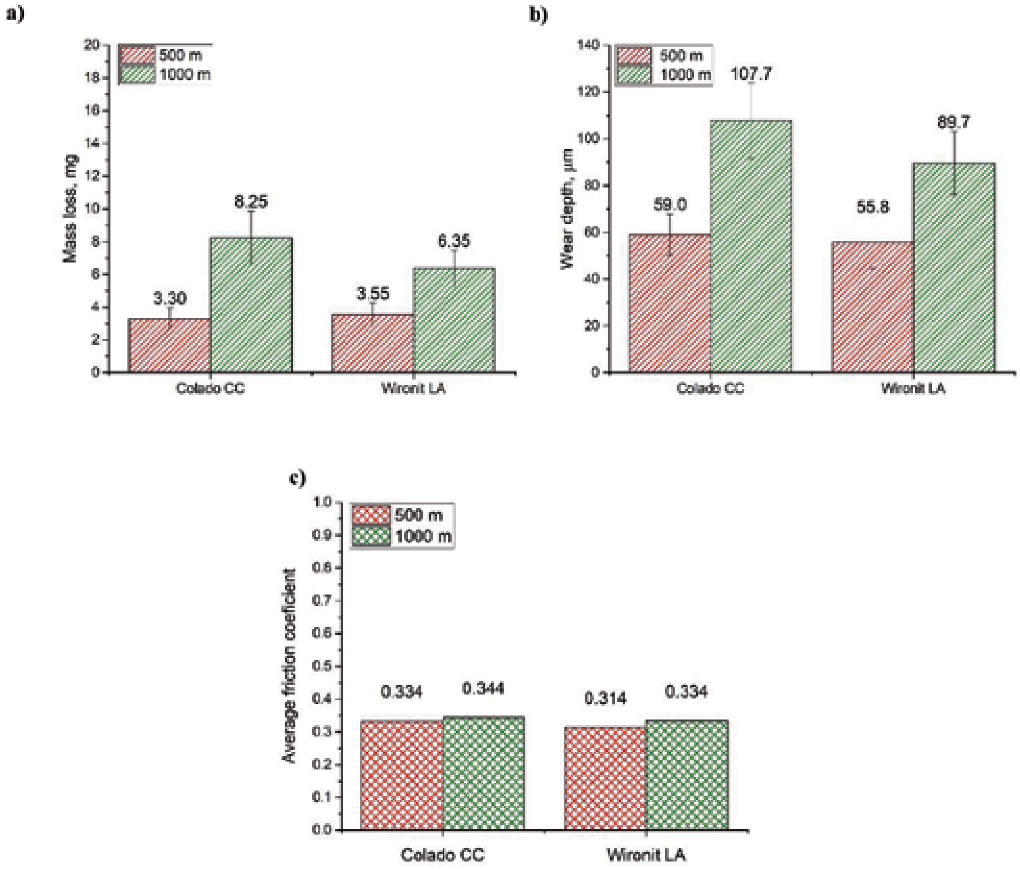


Fig. 5. The results of the tribological test for the Co-Cr alloys tested; a) the weight loss of the sample after the various tribological tests and the value of the coefficient of friction from the test, b) the depth of the resulting abrasion for each of the alloys tested, c) average value of the friction coefficient for investigated samples

Rys. 5. Wyniki próby tribologicznej dla badanych stopów Co-Cr; a) ubytek masy próbki po różnych testach tribologicznych oraz wartość współczynnika tarcia z próby, b) głębokość powstałego wytarcia dla każdego z badanych stopów, c) wartość średnia współczynnika tarcia dla badanych stopów

The analysis of the tribological test results shows that, at the initial stages of the wear process, we observe similar wear for both materials, both in respect of the mass loss and the volumetric loss (**Fig. 5**). For the friction path of 500 m, both materials demonstrate similar tribological properties. In turn, with the increase of the friction path and further material reinforcement as a result of the tribological operation, we can observe an increase in the wear resistance of alloy Wironit LA (Co-Cr-Mo) (**Fig. 5**). Increasing the friction path two times, i.e., to 1000 m, for the examined alloy, Wironit LA resulted in an almost two-fold increase of the mass loss as well as an increase of the depth of the formed abrasion by about 40% (**Fig. 5a**). In turn, in the case of alloy Colado CC (Co-Cr-W-Mo), one can observe an over two-fold increase of the mass loss value with a practically two-fold increase of the abrasion depth (**Fig. 5**). A gradual material reinforcement can explain such changes of the tribological parameters as a consequence of the tribological operation. At the initial friction stage, strong material wear occurs, connected with the distribution of the pressure force over a small sample area. A similar hardness characterises both materials, and so, with a lower friction path, the wear proceeds in both examined materials very similarly. When the tribological test time is prolonged two times (1000 m), we observe a gradual distribution of the initial pressures in the tribological contact on a larger surface area as well as the interaction of larger areas of the sample and the counter-sample. When the material has the possibility to reinforce itself during the trial, the presence of smaller spherical particles in the microstructure causes its higher wear resistance. In the case when the observed precipitates have a more complex irregular shape and are further apart from each other (λ), the reinforcement effect will be lower, which also translates to a slightly lower hardness evaluated by the static method **[L. 26]**.

While analysing the mean friction coefficient value for both tested alloys (**Fig. 5**), we observe that, for each analysed variant of the examined alloy Co-Cr with Mo and W microadditions, it is similar, and also, no different abrasion mechanisms are observed on the surface of the examined alloys. On this basis, we can conclude that significant participation of the particles spalled from the material on the observed tribological trial results. The presence of a third body in the form of defected spalled intermetallic precipitates would visibly increase the friction coefficient and affect the appearance of the abrasion area.

CONCLUSIONS

The performed dry tests of the abrasion wear resistance with the use of a roll-block type T-05 tester for commercial alloys from the Co-Cr-Mo (Wironit LA) and Co-Cr-Mo-W (Colado CC) systems made it possible to draw the following conclusions:

1. Commercial alloys from the Co-Cr-Mo and Co-Cr-Mo-W systems characterise their as-cast state in a dendritic structure with precipitates observed in the interdendritic spaces. We observe complex carbide phases Cr, Mo, W in the interdendritic spaces. The examined materials show significant segregation of elements like Mo and W into the interdendritic spaces.
2. The investigated alloys are characterised by a lower value of the mean friction coefficient, independent of the tribological trial's duration time, which points to the lack of changes in the wear mechanism and the increase of the test duration time. The materials undergo significant wear through microcutting and microridging. We observe a small participation of plastic deformation of the friction faces.
3. The abrasion wear resistance of the tested materials is connected with the geometrical character of the material microstructure after the solidification process. Similar hardness values of the examined materials resulted in a similar degree of mass and volumetric wear with a shorter friction path. The difference in the volume fraction and the mean interdendritic space area becomes visible in the case of longer tribological trials (1000 m); the material reinforcement during the test causes improvement of the material's resistance to abrasion wear. In the case of the examined Co-Cr alloys, an advantageous morphology of the interdendritic precipitates is constituted by smaller spherical particles, which more effectively influence the material's reinforcement process, directly improving its abrasion wear resistance.

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