Глубина износа стали при трении по ней шарового индентора с покрытием из никеля в восемь раз превышает износ стали при трении по ней индентора с КЭП Ni-$W_xMo_{1-x}O_3$. Суммарный линейный износ пары трения КЭП Ni-$W_xMo_{1-x}O_3$ – сталь при установившемся режиме изнашивания (2000 – 9000 циклов истирания) составляет 0,2 мкм, в то время как суммарный износ пары Ni – сталь – 18,6 мкм.

Сравнительные исследования процесса сухого трения показали, что если для никеля более характерен адгезионный механизм изнашивания, то для композитов – преимущественно абразивный, что приводит к значительно меньшему износу как покрытия, так и контртела.

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THE INFLUENCE OF PROCESSING CONDITIONS ON SURFACE LAYER PROPERTIES OF ANTIFRICTION CAST IRON GJS2131 PARTS

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Introduction. The destruction processes of machines and equipment begins in the material surface layers [1]. The conditions of the contact areas of the team-worked elements influence on it. It is necessary to meticulously forming of surface layers properties, counteracted the destructive action of the machine work conditions on the material, from which the part is produced [2]. The usage durability of machine parts closely connects with the properties of the surface layer. Therefore, different technological and exploitation methods may be used to form these layers, based on the various methods, among them cutting process. The results of researches of the surface layers properties of parts produced from antifriction cast iron GJS2131 when turning by cutters from different tool materials are introduced below.

Materials researched. The purpose of the research was to define the tool material, which is possible to obtain the most suitable surface properties with the maintenance of shape dimension tolerances. EN-GJS2131 cast iron was been tested, which has high wear resistant and used in piston inserts and piston rings in combustion engines. It is a material designed by industrial factories producing mould parts, which widely used in the constructions of motor vehicles. The structure of the tested EN-GJS2131 cast iron is shown on fig. 1, and in table 1 its chemical composition and properties are introduced.

Table 1. Chemical composition and properties of GJS2131cast iron

Element values in mass content composition [%]									Tensile Strength [MPa]
C	Cu	Si	Mn	P	S	Cr	Mo	Ni	
2.49	5.42	2.20	1.05	0.33	0.04	0.04	0.01	7.47	150

When turning, cutters with indexable inserts with index CNGA 120408 were used. They were produced from:

– regular boron nitrate CBN, covered by a layer of titanium nitrate TiN (CBN7050 of «Sandvik Coromant» firm) [3];

– ceramic based on silicon nitrate (CC6090 of «Sandvik Coromant» firm) [3]; this material has good abrasive resistance at high temperatures;

– sintered carbide hard alloy type K10 of «Mitsubishi» firm [4], which is typified by good abrasive resistance and impact resistance.

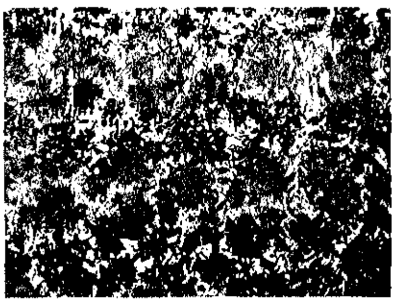
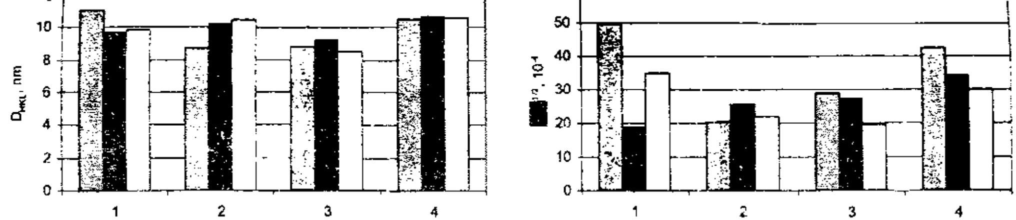


Fig 1. Cast iron GJS2131 with perlite-ferrite structure. Enlargement ×100

Processing of parts was realized on CNC lathe model Talent® 6/45 in dry turning conditions with the following cutting parameters range: cutting depth $a_p = 0.25$ mm, feed f from 0.03 to 0.3 [mm/rev], cutting speed V_c from 290 to over 1100 [m/min]. Such range of cutting parameters supplies the least and the greatest roughness parameters of the turned surface [5].

Strengthening of the surface layer were researched using a general purpose diffractometer ДРОН-3.0 with monochromatic CuK_{α} X-radiation. Difractogram processing has been realized on a base of «WinDif» program. Submicrostructure parameters of a surface layer was defined, such as medium dimension of coherent dispersal zone D_{HKL} according to the Seliakov-Sherrer



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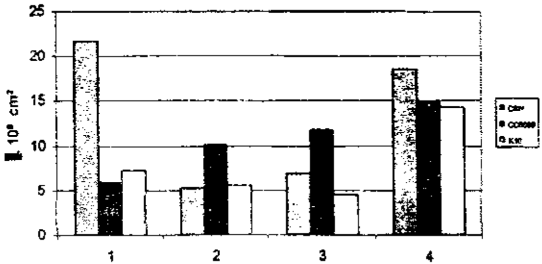

Fig. 2. Indexes values of GJS2131 surface layer parameters: *a*) dimension of coherent dispersal zone D_{HKL}; *b*) relative root-mean-square micro-deformations $\sqrt{<E^2>}$; *c*) dislocation density ρ (marking 1 – 4 accord to line numbers of the table 2)

equation; relative root-mean-square micro-deformation $\sqrt{<E^2>}$ according to the Seliakov-Sherrer equation; dislocation density ρ.

Results of researches. Investigations of the surface layer state were realized using a factor plan of 2^2 type. Investigation conditions are in the table 2.

Results of difractograms changes calculated by means of «WinDif» program are presenting on fig. 2.

Table 2. Conditions for testing of surface layer state

No	Normalized value		Actual value	
	X_1	X_2	V_c [m/min]	f [mm/rev]
1	−1	−1	292	0.03
2	−1	+1	292	0.3
3	+1	−1	1118	0.03
4	+1	+1	1118	0.3

Testing of the role of different indexes of surface layer on its general state was the subject of very research works. Their analyses have described in [6]. It has been determined that D_{HKL} dimensions of coherent dispersal zones and micro-distortion $\sqrt{<E^2>}$ have a varied effect on the material strengthening. At the time of testing of material strengthening when it's tempering it was determined that the temperature of the beginning of intensive increase of coherent dispersal zones is approximate to the temperature of beginning the removal of strengthening when tempering, but the temperature of micro stressing relaxation is not approximate. Basing on the simplest physical conceptions, Bragg showed that the durability of materials is inversely to the D_{HKL} dimensions. Later material strengthening while phase's changes and plastic deformations was associated with fragmentation of coherent dispersal zones, with changes of their heterogeneity degree, mutual turning etc. It explains the plastic deformation mechanism of metal. The slide along the crystal plates does not take place as a result of simultaneous displacement of groups of single atomic plates, but as a result of one type of displacement of atomic groups dispersing in crystal grids in defined directions. Such displacement sequence may go on in particular directions for long distances, as long as periodic correctness of the crystal grid remains at one direction. The process interrupts itself if the displacement encounters the disturbance of a properly constructed crystal grid, e.g. the border of a coherent dispersal zone. Therefore, the fragmentation of such zones causes the increase of metal resistance to plastic deformation.

Micro stressing has an auxiliary function in the strengthening of metal. They are not associated with resistance to plastic deformation but are characterized the properties of the given material crystal grains. It has been defined that multiply increasing or reduction of micro stressing may not cause significant changes in the values of material resistance to plastic deformations. The boundary of plasticity and hardness do not change even in the event of almost total disappearance of micro stressing. Such interactions between coherent dispersal zones and micro stressing may be explained, treating deformation of single areas as the atomic plates bending. If inter atomic forces are large enough to resist the bending of the coherent dispersal zone, this zone may exist in the metal. However, if these forces are insufficient and the destruction of this zone takes place, then each of the new make zones shall have lesser dimensions and lesser plastic deformation. Because plastic deformation connects with the dislocation movement, the occurrence of the hardening phenomenon means that there is an increase of resistance to dislocation movement in the deformed metal. This resistance increases together with the increasing dislocation density, which blocks mutually. Part of dislocations remains in crystallites and causes internal stressing, which counteracts relocation of other dislocations. In consequence, it causes a reduction of plasticity and strengthening of the material.

On the base of X-ray analysis one may confirm the superiority of CBN7050 material. The best combination of turning parameters are number 2 and 3 according to the table 2.

Conclusions. The influence of the tool material on the surface layer properties of the parts produced from antifriction cast iron was defined basing on results of X-ray testing. The reduction of dimensions of coherent dispersal zones and a lesser degree of atomic plate's deformation in crystal grid was indicated in the event that using inserts from CBN. This is observed as in the event of situation «relatively low speed great feed» as in the event «great speed low feed».

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МЕТОДИКА ИССЛЕДОВАНИЯ ВЛИЯНИЯ СМАЗОЧНЫХ МАТЕРИАЛОВ НА ТРИБОТЕХНИЧЕСКИЕ ХАРАКТЕРИСТИКИ ПОДШИПНИКОВ КАЧЕНИЯ

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Введение. Вопросы, связанные с определением потерь на трение в подшипниках качения в зависимости от состава и свойств используемых для их смазывания масел, представляют интерес для многих отраслей современного машиностроения. Известно [1], что в подшипниках качения наблюдаются такие виды потерь, как потери на упругий гистерезис в зонах контакта тел качения с беговыми дорожками колец, потери на трение скольжения между телами качения и сепаратором, кольцами подшипников и сепаратором (для некоторых типов подшипников). Потери на трение возникают также между торцами роликов и упорной поверхностью внутреннего кольца (для роликовых радиально-упорных подшипников), на площадках контакта, они обусловлены разностью мгновенных скоростей колец и тел качения (так называемое «дифференциальное трение») [2], а также верчением шариков. Особое место занимают потери на трение в смазочном материале, заполняющем гнезда сепараторов, площадки контакта и окружающем рабочие элементы подшипника. В этом случае имеет место преодоление гидравлического сопротивления.

Смазочные материалы, используемые для смазывания подшипников качения, имеют различные антифрикционные свойства и в разной степени снижают потери на трение. Различаются и потери на трение при различных концентрациях присадок в легированных маслах. В связи с возникновением новых масел и смазочных композиций возникает необходимость исследования их влияния на триботехнические характеристики подшипников качения.

Метод исследования. На кафедре «Машиноведение и детали машин» на экспериментальной установке ДМ-28М (рис. 1) производятся исследования влияния смазочных материалов на триботехнические свойства подшипников качения.

Установка позволяет определять характеристики трения покоя, а также проводить испытания при частоте вращения вала $0 < n \le 800$ об/мин и суммарной нагрузке на подшипники $0 < F \le 8000\ H$. В настоящее время проводятся испытания радиальных шариковых подшипников 208 серии с динамической грузоподъемностью $C = 32000\ H$ и статической грузоподъ-