ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

Strengthening Thermal Treatment of Wear-resistant Turbo-alloy Parts Manufactured by Gasification Model Casting

BakhodirTilabov, SherzodMamirov, JakhongirButunov, XurshidYusupov

Doctor of Technical Sciences, Almalyk branch of Tashkent State Technical University named after IslamKarimov,
Assistant of the department "Building machine" of the Almalyk branch of the Tashkent State Technical University named after Islam Karimov, Almalyk, Uzbekistan
Assistant of the department " Building machine " of the Almalyk branch of the Tashkent State Technical University named after Islam Karimov, Almalyk, Uzbekistan
Assistant of the department " Building machine " of the Almalyk branch of the Tashkent State Technical University named after Islam Karimov, Almalyk, Uzbekistan

ABSTRACT: This article presents the theoretical and practical foundations of the manufacture of cast parts for tillage and agricultural machinery and mechanisms by casting on gasified models. A technology has been developed for the production of polystyrene foam models of various types of products and the manufacture of molded parts of machines with wear-resistant carbide coating such as Sormait. A technique has also been developed for applying wear-resistant carbide coatings on the working surfaces of the foam model - parts when casting according to gasified models. A method for forming castings of parts with carbide coating up to three mm thick has been created. The quality of casting parts and the thickness of the applied wear-resistant carbide coatings were checked. The macro - and microstructures of carbide coatings obtained by molding on polystyrene foam gasified models were studied. The thickness of the carbide coating on specially prepared thin sections cut from casting parts with a coating thickness of 2.0-2.5-3.0 mm was also studied. The coating thickness was determined using an MIM-8M and Neofot-21 optical metallographic microscope with various magnifications from x100 to x1000. Along with this, the microstructure and phase composition of the hard alloy were studied. The hardness, microhardness, and depth of the hard-alloy coating were determined on the samples and the part obtained by casting on a polystyrene foam gasified model, on the working surface of which a powdered Sormite-type hard alloy was applied. The optimal heat treatment conditions with double phase recrystallization for these cast parts of machines and mechanisms have been developed. Proven that heat treatment with double phase recrystallization of such products increases abrasion resistance and durability 2-3 times higher than serial products. This developed technology has been tested and implemented in one of the largest giant enterprises of Uzbek Metallurgical Plant JSC with the best economic effect.

KEYWORDS: gasification casting, powder hard alloy with a binder, carbide coating thickness, hardness and micro hardness

I. INTRODUCTION

Most details tillage and agricultural machines and mining and metallurgical equipment operate under severe conditions of exposure to an abrasive medium. Therefore, the working surfaces of such parts are subjected to surface hardening by application wear-resistant carbide coatings by gasification casting. Application tcarbide coating is carried out by melting the metal coating surface of the part.

Structural state thardalloy coatings are formed in the process of solidification and cooling of the product. The final operation in most cases is a vacation. The use of parts with carbide coatings without special heat treatment is not sufficiently effective, since the possibilities to increase abrasive wear resistance are not fully realized due to insufficient hardness and instability of the structure.

It is advisable to obtain small-sized parts with carbide coatings on working surfaces at the same time when casting on polystyrene foam gasified models. In this case, a powdered hard alloy together with a binder, in the form of a paste, is applied to the working surface of the foam model of the product. The foam model is moulded into a foundry flask container with dry quartz sand.

When pouring liquid metal through the gate system, the foam model burns out, the resulting cavity fills the liquid metal. Upon contact of the molten metal with the cold walls of the mould, a hard crust forms, on which a powdered hard alloy of the Sormite type melts and combines with the solid crust of the solidifying casting.

There are a large number of compositions of cast hard alloys that are used as wear-resistant coatings. These are mainly high-carbon and high-chromium alloys of eutectic or hypereutectic compositions, which can be additionally alloyed with nickel, manganese, silicon, tungsten, vanadium, and titanium. During crystallization, these alloys form quenching structures with a significant amount of stable residual austenite. Cast hard alloy with such a structure is poorly machined (when necessary) and has insufficient wear resistance due to reduced hardness.[1]

In this paper, we solve the problem of increasing the abrasive wear resistance and durability of carbide parts obtained by casting using gasified models by using optimal heat treatment conditions with double phase recrystallization.

II. RESEARCH METHODOLOGY.

For research, we chose the composition of a hard alloy of the Sormite type, which does not have a large number of deficient alloying elements, ensures the completeness of phase transformations during the heat treatment (during annealing to reduce hardness, during quenching to obtain the highest hardness). Table 1 shows the chemical composition of the powdered hard alloy.

Table 1. The chemical composition of the hard alloy

The content of elements, in% (by weight)								
C	Si	Mn	S	P	Cr	Ni	W	Mo
3.0	1,5	0.8	0.04	0.04	22.0	1,2	0.2	0.08

The objects of research were samples obtained by casting 35GL steel according to gasified models. A paste-like paint containing a powdered hard alloy of the specified composition with a binder, a 4% solution of polyvinyl butyral in alcohol, was applied to the working surface of the model. The thickness of the paste was up to 3 mm. After drying the paste-like paint, the foam model was moulded with dry quartz sand. After installing the gating system, liquid metal was poured. On the working surface, the powdered hard alloy melted, and upon cooling the entire casting crystallized with the formation of a cast carbide coating.[2].

Finished samples were cut across the coating and studied the macro - and microstructure, determined the hardness of the samples, as well as the change in microhardness along the depth of the coating. The phase composition and the fine structure state of the metal base of the coating were studied by - ray diffraction[4].

Heat treatment of the samples included the following:

- low annealing at 700-720^0;
- quenching from heating temperatures 900-920^0, 1000^0, 1100^0, 1150^0;
- vacation at temperatures of200-250^{0}C.

Some of the samples were thermally treated with double phase recrystallization - the first quenching from various heating temperatures, intermediate tempering at 600-650^0 , the second quenching 900-920^0 , tempering 200-250^0 . According to studies [5, 6], this heat treatment strengthens the metal base of the alloy due to an additional increase in the dislocation density. Tests for abrasive wear were carried out on a PV-7 device when the polyurethane screw was rubbed over the surface of the test sample in the presence of quartz sand[7].

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

III. RESEARCH RESULTS AND DISCUSSION.

Micro studies have shown that the resulting wear-resistant coating in depth has a different composition and structure (Fig. 1). A hypereutectic structure with excess hexagonal and prismatic carbides is formed at the surface of the coating. Further along the depth of the layer are followed by zones of eutectic and hypereutectic compositions with sharp transitions to the structure of the hypereutectoid and eutectoid steel of the metal base.[3]

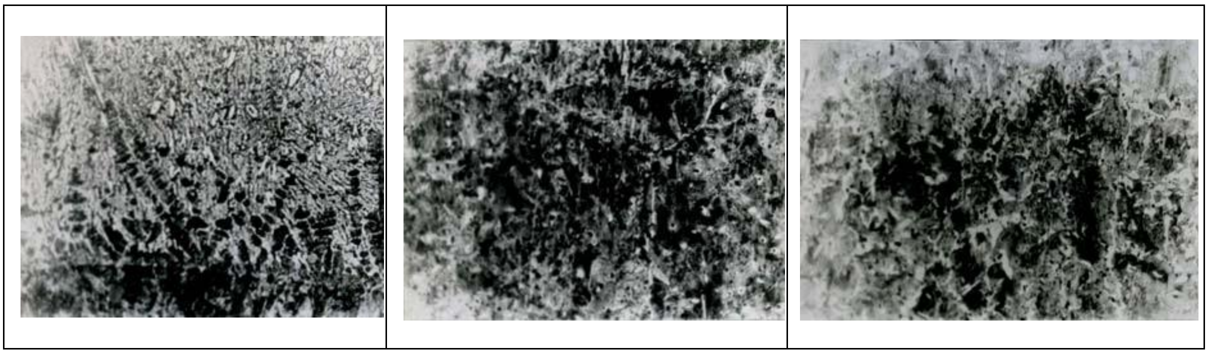

Fig. 1.Microstructures of the carbide coating obtained by casting parts from 35GL steel according to the gasified model.

The formation of a high-carbon sublayer under a carbide coating is associated with the diffusion of carbon from the composition of the powder coating into the crust of the solidified metal, as well as the carbonization of the foam model

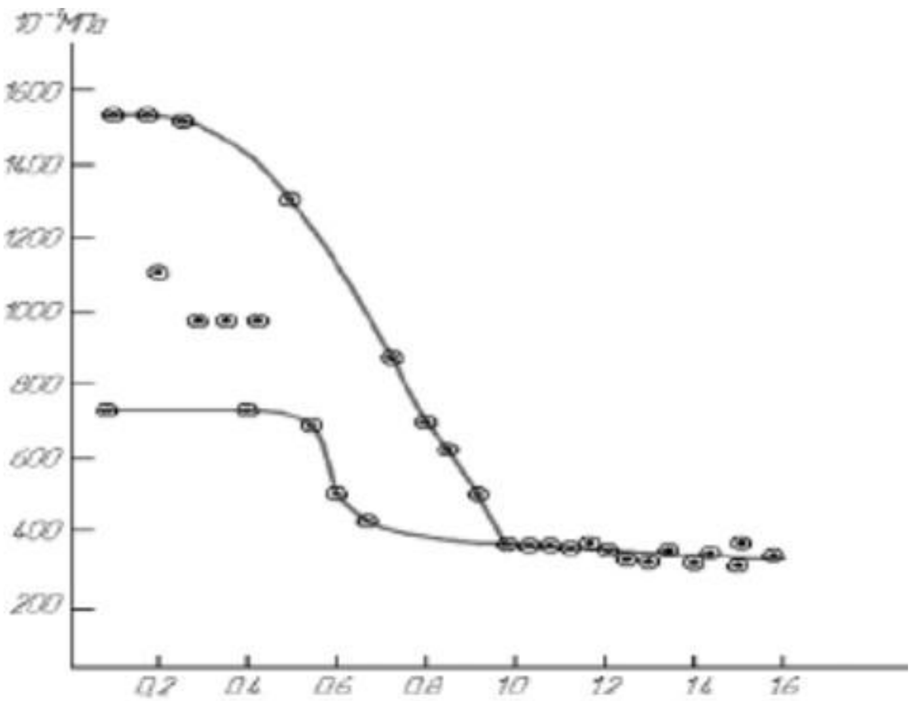

Fig. 2. The change in the microhardness of the carbide coating in depth from the surface of samples made of 35GL steel obtained by casting according to the gasified model.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

by the combustion products. The total thickness of the carbide coating was 2.5-3.0 mm.

An -ray phase analysis of the surface of the samples showed the presence of carbides of the M7C3, M23C6 type and the presence of - phases of iron. The microhardness of the layer in depth from the surface varies over a wide range, which is associated with the presence of various structural components (Fig. 2).

When the samples are quenched from a heating temperature of 900-9200 , the location and shape of the primary carbides does not change, however, the lower microhardness values significantly increase in the band of their values from NV 720 10-1 MPa to NV 840-1100 10-1 MPa. At higher heating temperatures for quenching, secondary carbides dissolve in austenite. Due to the high alloying of the solid solution in the zone with a depth of 0.5-0.6 mm, an increased amount of residual austenite is detected and microhardness is reduced. At a depth of 0.7-0.95 mm from the surface of the coating, the metal base of the alloy has only a martensitic structure. Microhardness rises again. Further along the depth of the high-carbon sublayer, a monotonic decrease in microhardness is observed.

It is known that the wear resistance of high-chromium alloys largely depends on the state of the fine structure of the metal base. The judge on the level of defectiveness of the crystal structure by the dislocation density, which was found from the physical width of the x-ray line of the (211) -phase [4]. The research results are shown in table 2.

Table2.The dislocation density in the crystal lattice of the metal base (α-phase) of the wear-resistant carbide coating from the quenching temperature, ρ·1011·1/cm^2

Quenching temperatures, 0C	900-920	1000	1100	1150
Dislocation density	0.35	3.49	4.82	1.98

As can be seen from table 2, the level of dislocation density depends on the quenching temperature and has an extremum at 11000 . However, when quenching from high heating temperatures, the amount of stable residual austenite increases, which reduces wear resistance. The use of heat treatment with double phase recrystallization eliminates this disadvantage. The first phase recrystallization takes place with heating to an extreme temperature. Quenching provides the formation of a structure with a high level of dislocation density. Intermediate tempering stabilizes the dislocation structure. Repeated phase recrystallization (in this case, with heating900-9200) passes under conditions of inheritance of elements of the original substructure, but with a minimum amount of residual austenite. The research results are shown in table3.

Table3.The dislocation density in the crystalline structure (α-phase) of the metalbase of the wear- resistant carbide coating, depending on the temperature of preliminary hardening,ρ·1011·1/cm^2

Temperature pre hardening, 0C	900-920	1000	1100	1150
Dislocation density	2.24	2,33	3.63	2,33

The microstructure of all samples after repeated phase recrystallization at 900-9200 is coagulated primary and finely divided secondary carbides in a finely needle martensitic base with a small amount of residual austenite.

IV. CONCLUSION

The introduction of heat treatment in the technology of creating carbide coatings significantly increases their wear resistance [8]. Laboratory tests show that abrasion resistance is in good agreement with the structural state of the

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 5 , May 2020

coatings. The research results show that the amount of residual austenite and the state of the fine structure of the metal base simultaneously affect the value of abrasive wear resistance. By adjusting the structure parameters of the carbide coating (in this case, obtained by casting a part according to the gasified model) by heat treatment, it is possible to significantly increase the wear resistance. Only an introduction to the manufacturing technology of cast parts with a wear-resistant carbide coating of hardening with 900-9200 increases the wear resistance by almost 1.8 times, and the use of heat treatment with double phase recrystallization [9.10] increases the wear resistance and durability of cast parts 2-3 times higher than serial products. The developed technology for manufacturing cast parts of machines with wear-resistant carbide coating by casting according to gasified models was introduced into the production of Uzmetkombinat JSC with the best economic effect.

REFERENCES

[1].MukhamedovA.A.,FarmanovA.K.TilabovB.K.Improving the wear resistance of cast parts with carbide coatings by heat treatment // Mining Journal, Moscow - Almylik, 2009. No. 8. - S.95-97.
[2]. Tilabov B.K. New technologies for manufacturing cast parts of agricultural machines with hard-alloy wear-resistant coating by gasification models and prospects for their development // Scientific-Technical and Production Journal of Agriculture of Uzbekistan. - Tashkent, 2008. No. 2. - S.41-43.
[3]. Khrushchev M.M. and others. Wear resistance and structure of hard surfacing. - M.: Mechanical Engineering, 1989 .-- 94 p.
[4]. UmanskyYa.S. and others. Crystallography, radiography and electron microscopy. - M .: Metallurgy,1988 .-- 629 p.
[5]. Mukhamedov A.A. The influence of thermal history on the structure and properties of steel.Physics of metals and metal science, Moscow, 1992.No. 11. - S. 92-99.
[6]. Tilabov B.K. The effect of heat treatment on the durability of cast parts with wear-resistant coatings. Togliatti State University (TSU), RF. Proceedings - II International Scientific and Technical Conference. Part I. Russia. - Tolyatti, 2008 .-- S.145-148.
[7]. Tenenbaum M.M., Bershtein D.B. Modeling the process of abrasive wear // Sat. Modeling friction and wear. - M.: NIIMash, 1989 .-- P.82-89.
[8].Tilabov BK Heat treatment of wear resistant hardalloved coating of the details contained by casting on gasified models. Journal of Technical University of Gabrovo. Bulgaria 2015. Vol. 49. - S.11-14.
[9]. Tilabov BK Improving working efficiency and durability of cast parts of tilling machines. European Science Review.East West Association for Advanced Studies and Higher Education GmbH. Vena.Austria, 2016. # 7-8. - S.23-27.
[10]. Tilabov BK Increase the service life of cast parts tillihg machines // International Conference "Global Science and Innovation" March 23-24, 2016. USA. Chicago, 2016 .-- S.222-225

AUTHORS' BIOGRAPHY

Tilabov Bahodir Kurbanovich, Doctor of Technical Sciences, Professor, Head of the Department of Mechanical Engineering, Faculty of Power Engineering and Mechanical Engineering, Almalyk Branch of Islam Karimov Tashkent State Technical University.	
Yusupov Xurshid Normumino'g'li, Assistant of the Department of Mechanical Engineering, Faculty of Power Engineering and Mechanical Engineering, Almalyk Branch of Islam Karimov Tashkent State Technical University.	

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 7, Issue 5 , May 2020

Mamirov Sherzod Sheralio'g'li, Assistant of the Department of Mechanical Engineering, Faculty of Power Engineering and Mechanical Engineering, Almalyk Branch of Islam Karimov Tashkent State Technical University.	
Butunov Jaxongir Ro'ziqulovich, Assistant of the Department of Mechanical Engineering, Faculty of Power Engineering and Mechanical Engineering, Almalyk Branch of Islam Karimov Tashkent State Technical University.