

# A method for increase abrasive wear resistance parts by obtaining on methods casting on gasifying models

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**Abstract.** Method optimizes hardening working layer parts', working in high-abrasive conditions looks in this work: bland refractory particles WC and TiC in respect of 70/30 wt. % prepared by beforehand is applied on polystyrene model in casting' mould. After metal poured in mould, withstand for crystallization, and then a study is carried out. Study macro- and microstructure received samples allows to say that thickness and structure received hardened layer depends on duration interactions blend harder carbides and liquid metal. Different character interactions various dispersed particles and matrix metal observed under the same conditions. Tests abrasive wear resistance received materials of method calculating residual masses was conducted in laboratory' conditions. Results research wear resistance showed about that method obtaining harder coating of blend carbide tungsten and carbide titanium by means of drawing on surface foam polystyrene model before moulding, allows receive details with surface has wear resistance in 2.5 times higher, than details of analogy steel uncoated. Wherein energy costs necessary for transformation units mass' substances in powder at obtained harder layer in 2.06 times higher, than materials uncoated.

## 1. Introduction

Open pit is considered most effective way pray useful fossils. Process excavation appear most important element technological chain open pit, which continuity largely determined durability exchangeable teeth buckets quarry excavators, details drilling equipment etc., which experience direct interaction with the rock. Details working in extreme abrasive wear conditions during excavation and exploitation particularly strong and abrasive solids (a large number of favourably oriented cutting edges on the surface fragments blasted rock, the dominant role metal micro cutting, intense impact loads, etc. [1]), which causes their rapid failure [2,3].

Analyses failure details different appointments showed, that, despite on different conditions their works, the main reason failure serve wear into abrasion process in interaction with abrasive material [4]. Hardening by dispersed parts introducing there in crystallizing liquid and deposition hardened layer a certain thickness on the surface details can be method increase mechanical characteristic materials [5-7]. The letter method has been used as a basis in this work.

## 2. Execution of works to obtain experimental' samples

Method was offered for increase wear resistance working edges, consisting in that mechanical hardening blend applying on the surface foam polystyrene model, which is further working. The proposed coating represents blend fine powders (2-5  $\mu\text{m}$ ) carbide tungsten and carbide titanium. It provides simplicity and cheapness production blend. The ratio of components is (in wt. %) - 68:28:4 (WC:TiC:parafine).

An experiment was been on samples of arbitrary shape as approbation of the method. Details received of methods lost foam casting. This technology implies covering polystyrene models' anti-weld blends,



which is protecting the metal from fumes to moulding sand. Working part details' before molding was covered mechanical strengthening blend. A canal was cutter out into polystyrene models for ensuring the better interaction liquid metals and coating. Gating system was covered anti-weld paint', after the bland has solidified, then dried. Received models were formed in sand before dried. Steel AISI 1020 used as basic metal. Choice of steel was due to minimal content' carbon and alloying components, which can influence on the process at the interaction of the strengthening mixture and basis metal details'. 3 casting obtained during the experiment ('figure 1').

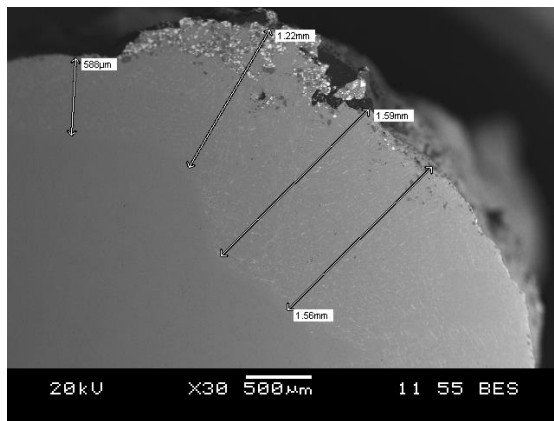


**Figure 1.** Typical configuration samples obtained on results experiment.

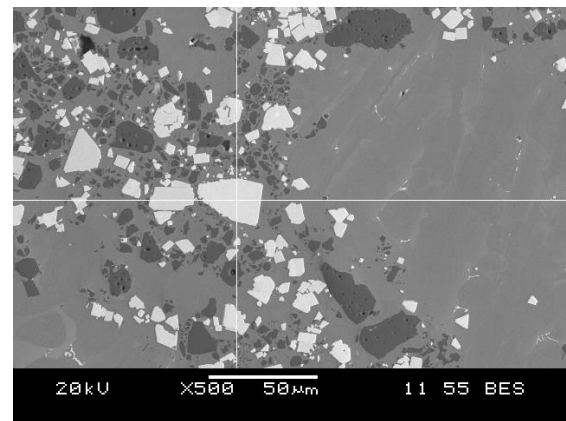
### 3. Study of the structure of samples

Study of the structure obtained samples with the help of an inverted metallographic microscope 'C. Zeiss Observer. D1m' equipped with an image analyzer 'Thixomet.PRO' [8], as well as using an electronic scanning microscope 'JEOL JSM-6460 LV'. Structure study revealed, that dispersed particles titanium carbides' and tungsten in blend, reacted with the liquid metal and formed a coating 'figure 2'. The interaction of these components with the liquid melt occurred, but complete dissolution of tungsten carbides (lights) and carbides titanium (dark) not observed 'figure 3, 4'. It's related with high speed crystallization metal. Chemical composition in volume samples represented in table 1.

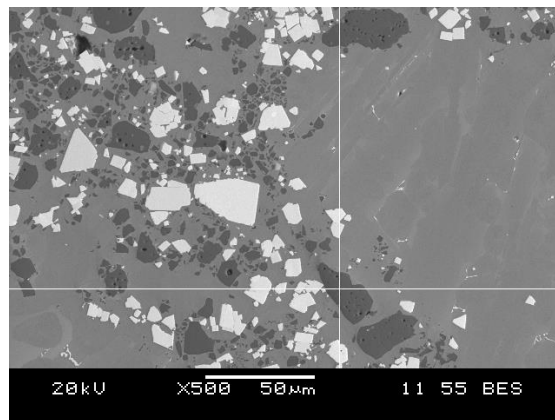
The complete dissolution of hardening particles in the surface layer castings 'figure 5', and not their finding in the form separate phases, is observed when studying the microstructure of the samples obtained in the course repeated experiment. The remaining carbide particles, which did not have time to dissolve in the volume of the metal, are observed at large magnifications 'figure 6'. The presence non-metallic inclusions in it, containing a significant amount (20-22 wt. %) of titanium also indicates the dissolution particles in the surface layer indicate 'figure 7'. The chemical composition detected particles in the volume of the samples obtained during the second experiment is shown in table 2. The inconsistent compositions and behaviour of the dispersed particles of tungsten carbide and titanium carbide on interaction with the metallic melt in the first and second experiments are probably related to their different wettability characteristics: under the same conditions, the nature and phenomenon of the given process for different particles differs, as shown by the authors of [9-13].



**Figure 2.** Outer layer samples, obtained during the experiment,  $\times 30$ .



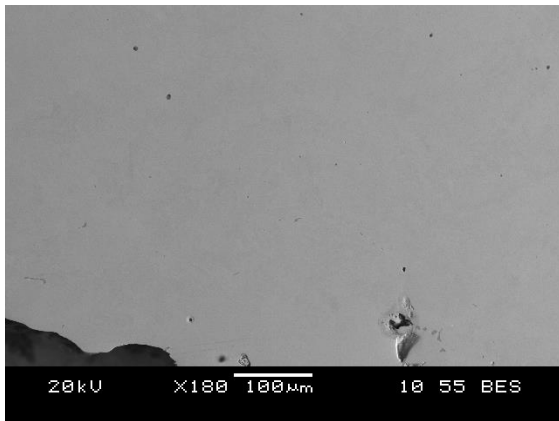
**Figure 3.** Detected particles of tungsten carbides in samples, obtained during the experiment,  $\times 500$ .



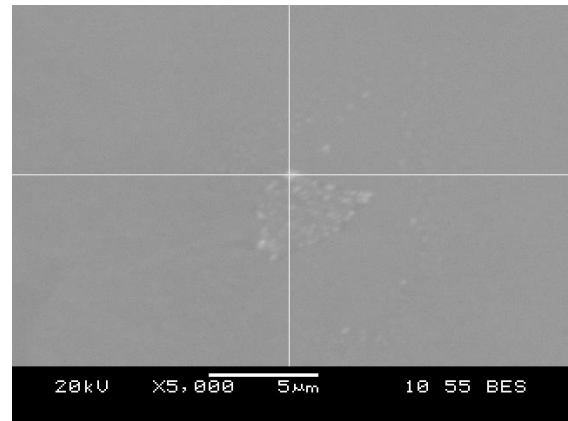
**Figure 4.** Detected particles of titanium carbides in samples, obtained during the experiment,  $\times 500$ .

**Table 1.** Chemical composition detected particles.

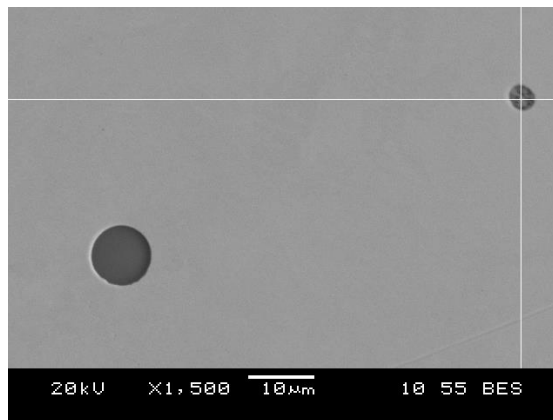
|          | Content of elements (wt. %) |       |      |       |
|----------|-----------------------------|-------|------|-------|
|          | C                           | Ti    | Fe   | W     |
| <b>3</b> | 10.98                       | -     | -    | 89.02 |
| <b>4</b> | 14.62                       | 84.40 | 0.98 | -     |



**Figure 5.** The outer layer samples, obtained during the repeated experiment,  $\times 100$ .



**Figure 6.** Detected particles of tungsten carbides in samples, obtained during the repeated experiment,  $\times 5000$ .



**Figure 7.** Detected inclusions with titanium content in samples, obtained during the repeated experiment,  $\times 1500$ .

**Table 2.** Chemical composition detected particles.

|          | Content of elements (wt. %) |       |      |      |      |       |      |       |       |
|----------|-----------------------------|-------|------|------|------|-------|------|-------|-------|
|          | C                           | O     | Si   | P    | S    | Ti    | Cr   | Fe    | W     |
| <b>6</b> | 7.01                        | -     | -    | 6.31 | -    | -     | 3.69 | 63.31 | 19.68 |
| <b>7</b> | 3.51                        | 17.94 | 8.11 | -    | 5.53 | 21.67 | -    | 43.24 | -     |

#### 4. Study of wear resistance samples

The wear resistance of the samples was investigated under laboratory conditions by weighing the residual masses. The study of abrasion resistance was carried out by abrasive abrasion with a certain length of abrasive tape on which the sample was placed under load; the study was conducted in 2 iterations. Wear resistance was measured on the samples obtained during the repeated experiment, with the surface of the obtained sample, the inverse of the "working" (on which the reinforced layer was obtained), as the standard. Also, after measuring the weight loss of the test samples, the energy spent on converting a unit of mass of substances into a powder ( $A$ , [MJ/kg]) was calculated.

**Table 3.** Results of measurement of wear resistance.

|                            | Reference | The resulting sample |
|----------------------------|-----------|----------------------|
| <b>m<sub>0</sub>, g</b>    | 4.6864    | 4.6520               |
| <b>m<sub>1</sub>, g</b>    | 4.6845    | 4.6512               |
| <b>m<sub>2</sub>, g</b>    | 4.6826    | 4.6505               |
| <b>Average weight loss</b> | 0.002     | 0.0008               |
| <b>A, MJ/kg</b>            | 4.1       | 8.45                 |

## 5. Conclusion

According to the obtained data, can be observed that the method for obtaining hardened coatings from a blend of tungsten carbide and titanium carbide by applying it to the surface of a polystyrene model before moulding into casting moulds allows producing parts with a surface having a wear resistance 2.5 times higher than that of parts made from Similar to the unalloyed steel grade. At the same time, the energy expenditure necessary to convert a unit of mass of substances into powder from the resulting hardened layer is 2.06 times greater than for a similar material without coating. At the same time, the method of obtaining a reinforcing mixture is simple and cheap. The main criterion, which must be paid attention in the production of parts - a sufficient supply of liquid melt to the details. This is necessary for a longer crystallization time of the metal and, correspondingly, for a longer time of its interaction with dispersed refractory particles.

## Acknowledgments

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