

Enrichment of Casting Surface in Founding Process

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Abstract

A lot of cast steel and cast iron properties, also usable, depend on physical and chemical properties of surface layer, such as: hardness, corrosion resistance, abrasive wear resistance. The paper presents directly method of surface enrichment on casting in founding process. Layer in form of high-speed steel HS 18-0-1plate was placed on G25CrSiMnMoNi 4-4-4-2,5-4 cast steel hammer of crusher. To investigations it was used light microscopy and scanning electron microscope. Microanalysis of chemical microanalysis of chemical composition and hardness measurements of transient zone between cast steel and steel were made. Analysis of research result show that, exists possibility of increase in hardness and abrasive wear resistance by put on casting surface a tool steel or sintered carbides plates, which are from scrap after waste of turning tool or face milling cutter. Moreover, applied activated alloy is very useful in this method of casting surface enrichment directly in founding process.

Keywords: Wear resistant alloys, Cast steel, High-Speed steel, Surface, Hardness

1. Introduction

A lot of cast steels properties, also usable, depend on physical and chemical properties of surface layer, such as: hardness, corrosion resistance, abrasive wear resistance. Properties of cast surface layer depend on self-cooling conditions and surface reaction of metal / casting mould, that is on influence type of casting mould material to cast surface layer in time pouring mould and self-cooling cast [1÷14].

Increase in life of casted machine elements, which works in difficult conditions, can be obtained by use of composite alloy layers on casting surface [1, 2].

Composite alloy layers consist of matrix (for example metals and their alloys) and reinforcement (for example carbides or borides). This coupling with suitable technological process leads to obtainment of composite alloy layers with demanded useful properties [1, 2, 6, 7].

Structure and properties of foundry composite layers can be parted on different characteristic types [1÷15]:

Type I – melting point of casting material is larger than melting point of covering materials. In this layers does not occur nonfuse grain of covering.

Type II – structure as result of interaction between materials of covering and casting. Melting point of covering material is larger than melting point of casting material. Melting and dissolve of covering grain is only partial.

Type III – structure as result of penetration of casting materials in high-melting covering materials. Result from penetration is mount of covering grain in surface of casting.

Type IV – structure as result of chemical reaction during pouring mould. This layers have diffusion character.

Among stages of composite alloy layers forming (mainly for layers of type II and III) very important are:

- heat flow between casting – layer – mould,
- wet of porous layer by metal,
- penetration of layer by metal,
- solidification and segregation of constituent of layer,
- diffusion in solid state.

Table 1.

Chemical composition of the investigated materials

Material	Mass contents in %										
	C	Mn	Si	P	S	Cr	Ni	Mo	W	V	Cu
Cast steel G25CrSiMnMoNi 4-4-4-2,5-4	0,22	0,50	1,10	0,035	0,035	0,60	1,50	0,20	–	0,10	–
High-speed steel HS 18-0-1	0,75	0,40	0,50	0,03	0,03	3,50	0,40	0,70	17,00	1,40	0,30

2. Range of studies

The main aim of studies was to obtain on surface of cast steel (tab.1) directly in founding process a alloy layer. This layer influences on improvement of technological properties and lengthen life of casting. The investigations were made using castings of hammer of crusher (fig.1), which surface was reinforced by high-speed steel HS 18-0-1 plate (tab.1 and fig.2).

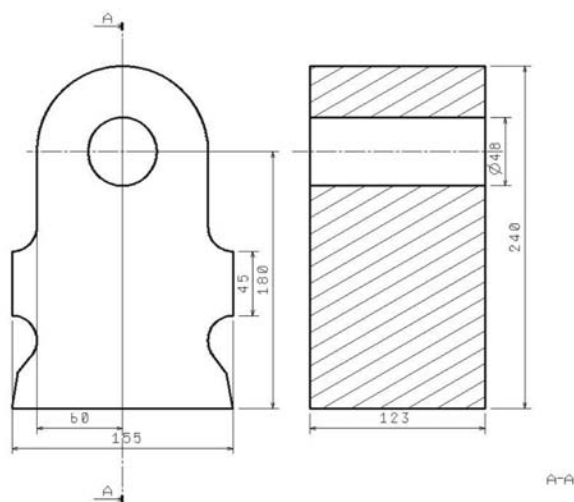


Fig. 1. Hammer of crusher

Conditions of formation of alloy layer on cast steel were put:

- wear resistant cast steel G25CrSiMnMoNi 4-4-4-2,5-4 was casted,
- founding to conventional sand mould,
- flux was used to increase of quality of joint between matrix and reinforcement phase.

Preparation of plates is very important because influences on quality of diffusion joint. The main aim of surface preparation is decrease, elimination of oxides and increase of wettability. High-speed steel HS 18-0-1 plates were cleaned first with use of mineral spirits and ethyl acetate. Next, were cleaned with use of ultrasonic washer IS – 5.5 with $f = 25$ kHz.

To increase of plates wettability was used activated alloy (flux) with compounds of boron:

- borax $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10 \text{H}_2\text{O}$,
- boron acide B_2O_3 ,

and ferroalloys FeCaSi:

- Ca = 13÷30%,
- Si = 50÷60%.

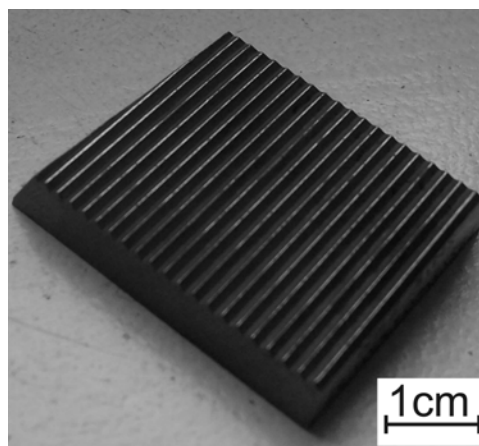


Fig. 2. View of high-speed steel HS 18-0-1 plate

In investigations were used conventional sand mould with zirconal covering in mould cavity. In corners of mould cavity i.e. in corners of hammer working surface were placed reinforcement plates (fig. 3).



Fig. 3. View of mould cavity with reinforcement plates in corners

In aim of quality assessment of joint between matrix and reinforcement was made metallographic examinations with use of

light microscopy Nikon EPIPHOT-TME and scanning electron microscope Philips XL30 with microspectrometer EDAX. Metallographic examinations of the material structure were made on light microscope with magnification from 100x to 600x and on scanning electron microscope with magnification from 200x to 1000x. Surfaces of samples which were prepared for microstructure analysis were etched with use of solution of:

- 10cm³ hydrochloric acid,
- 5g ferric chloride,
- 50cm³ ethyl alcohol,
- 50cm³ distilled water.

Hardness examinations were made on ultrasound MIC2 hardness tester with load 49N.

3. Results and analysis

Directly in founding process was obtained enrichment of G25CrSiMnMoNi 4-4-4-2,5-4 cast steel surface with use of high-speed steel HS 18-0-1 plates. On figure 4 is presented casting of hammer of crusher with reinforcement in form of high-speed steel plates, which were placed in corners of working surface.

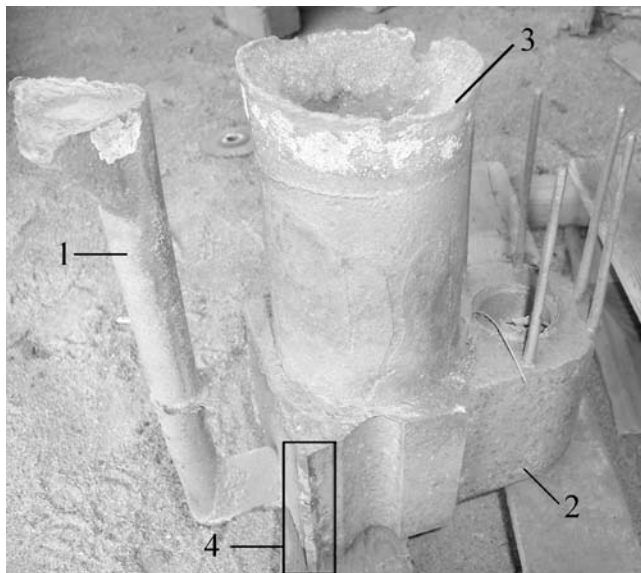


Fig. 4. View of hammer of crusher casting after cleaning of moulding sand: 1 – gating system, 2 – hammer, 3 – riser head, 4 – produced layer

Selected results of metallographic research are presented on fig.5. Analysis of this research result show that joint between matrix i.e. cast steel and reinforcement i.e. high-speed steel has good quality. Increase of hardness in transient zone (tab.2) result from formation of carbides as result of diffusion of wolfram and vanadium from rainforcement to cast steel, what was observed in realized microanalysis of chemical composition.

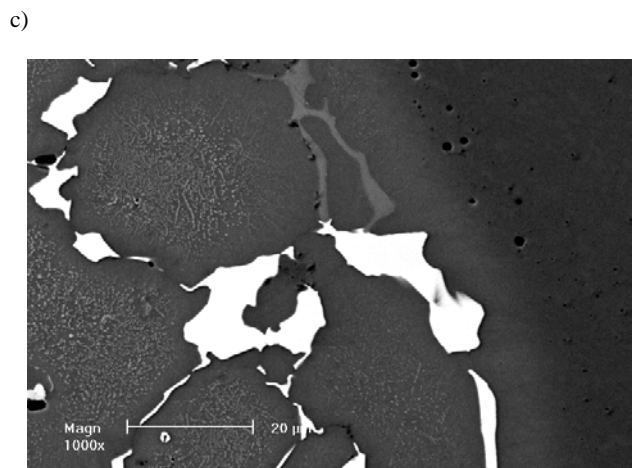
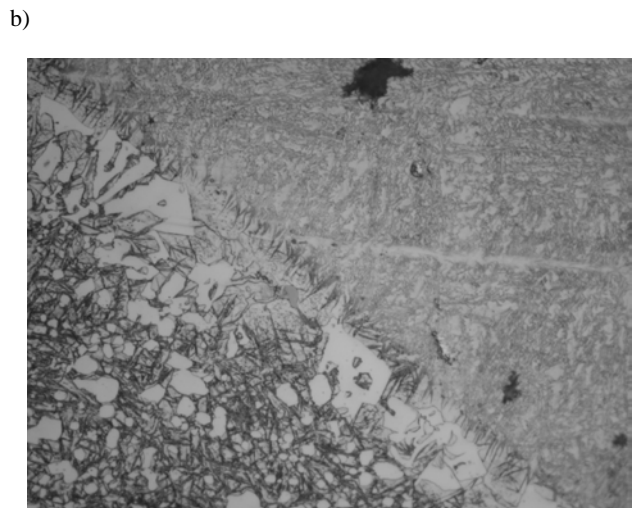
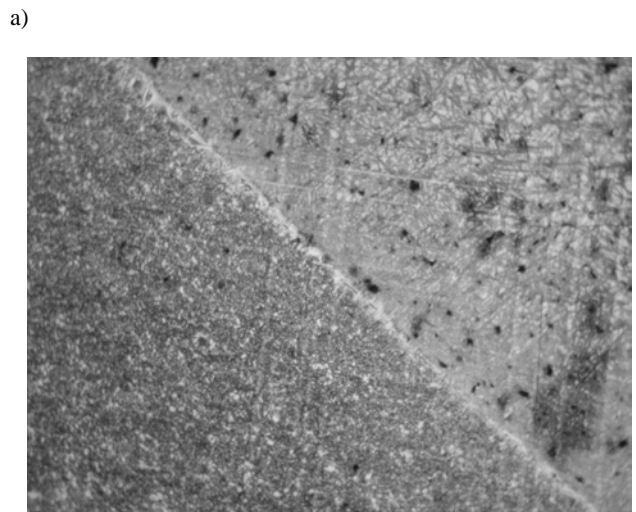


Fig. 5. Microstructure of transient zone between cast steel (down) and high-speed steel (up): a) 100x, b) 600x, c) 1000x

Table 2.
Result of hardness measurements

Area	HV5
Cast steel: G25CrSiMnMoNi 4-4-4-2,5-4	502
Transient zone	609
High-speed steel: HS 18-0-1	550

4. Conclusion

Based on conducted studies following conclusions have been formulated:

1. Possibility have been shown of cast steel surface enrichment directly in founding process by reinforcement with use of high-speed steel HS plates.
2. Advantage of presented technology is possibility of use of reinforcement from scrap after waste of turning tools or face milling cutters.
3. Important aspect of presented technology is suitable preparation of high-speed steel plates.
4. Applied activated alloy (flux) is very useful in this method of enrichment of casting surface directly in founding process.

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