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The Temperature of the Beginning of Alloy Layer Forming Process on the Steel Cast

J. Szajnar, A. Walasek *, C. Baron

Faculty of Mechanical Engineering, Foundry Department, Silesian University of Technology
ul. Towarowa 7, 44-100 Gliwice, Poland
*Corresponding author. E-mail address: agnieszka.walasek@polsl.pl

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Abstract

In this work the results of experiment connected with the problem of formation surface layers on the steel castings. There was an attempt to determine two factors: temperature (premould be higher up 1300^{o}C) and time (heating composite premould). The purpose of the argument was prove of creation surface composit layer in the consequence of heat composite premould (to above temperature of 1300^{o}C). The purpose of conducted research was tests control parameters (have an influence on diffusion process).

Keywords: Ferrochromium, Diffusion, Composite premould

1. Introduction

The research connected with the layer and composite cast have been carried out in Foundry Department of Silesian University of Technology for several years [1.2]. Recently, the layer casts have become the most interesting because of great industry demand for the parts of machines resistant to abrasive wear. The steel casts need to be subject to heat treatment or chemical constitution modification in order to gain high resistance to abrasive wear. It is not economical. The foundry technology of surface alloy layers on the steel cast forming satisfies the needs of contemporary industry: high hardness, strength, resistance to abrasive wear and concurrently high plasticity of the core. The process of forming such layers is possible thanks to foundry technology of forming the element with required properties not for all cast but only for chosen parts [10].

The technology of composite layer forming process make it possible to obtain in a chosen place many desired properties:

- great hardness, much bigger then the one of basic cast,
- great wear resistance, much bigger then the one of basic cast,
- great thickness of the alloy composite layer depending on the work conditions of the cast wall,
- two – stage heat treatment is not necessary.

The foundry method of alloy layer forming process on the cast is the following. First, the mould is prepared by drift of alloy layer (FeCr800) to proper cavity (fig. 1). Next, it is poured by liquied metal [3, 9, 12, 14]. Composite alloy layer is obtained as a result of cooperation between cast steel poured to the mould and alloy coat [4].

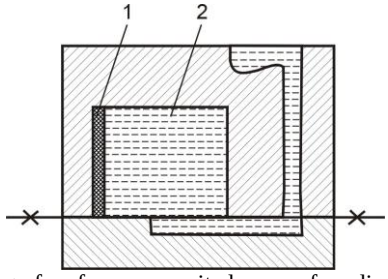

Fig. 1 Forming of surface composite layers – founding method; 1 – composite premould (FeCrC);2 – liquid metal (steel casting)

Surface layer forming process depends on many chemical and physical factors [15]. First of all, the obtain properties depend on cooling conditions and the reaction on the surface metal/pad (it means the kind of interaction between the pad material and surface cast layer) [11,13]. The size of the pad grain and material also influences the quality of composite layer. The pad should characterize the following properties [5]:

- the suitable graininess of the dispersion material,
- non gassy creative binder,
- exactly determined thickness.

2. Point of research

The main purpose of the research was determine temperature and the time of creation composite layer and the observation of coinciding phenonema.

On the base of the research results was made attempt to determine beginning of creation composite layer according to variable technological factors.

The purpose of the argument was prove of creation surface composit layer in the consequence of heat composite premould (to above temperature of 1300^{o}C).

The research was done by following stages:

- choose shape of sample to recreate thermal conditions in the correct cast mould,
- selection proper (right) parameters (to do research),
- registration the courves of the temperature during the time change,
- analysis of the structiure.

3. Proper tests

Material used in the research was the high-carbon ferrochromium FeCr800 and cast steel. In the fig. 2 was shown the geometry of sample and the way of mounting both of materials. First part of the sample was mixture of the high-carbon ferrochromium of the granularity from,2 to 0,3 mm and solution of etyl acetal $C_4H_8O_2$ used as a glue. Chemical compositions of FeCrC was shown in table 1. Second part prepared sample was low – carbon cast steel (0,3 %C). In each samples was made hole of diameter 3mm (like in the fig. 2) where will be later put thermoelement. In this way prepared sample was placed in quartz tube. Small sizes of sample gave possibility to quick preheat materials above temperature of 1300^{0}C- presumed level of temperature of creation composite. Shape of mould used during the research was choosen to vary thermal conditions in mould - depented on face cast thickness (step). Samples were placed in the centre each of the level (step) (Fig. 3).

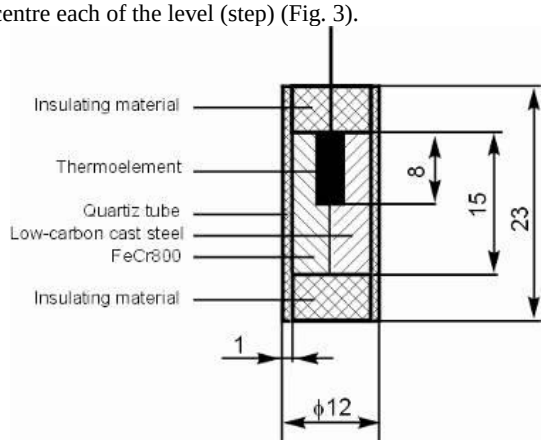

Fig. 2 Execution sample

Table 1.
The chemical composition of FeCrC used for researches

Material	Fe%	Cr%	C%
FeCr800	26	65	9

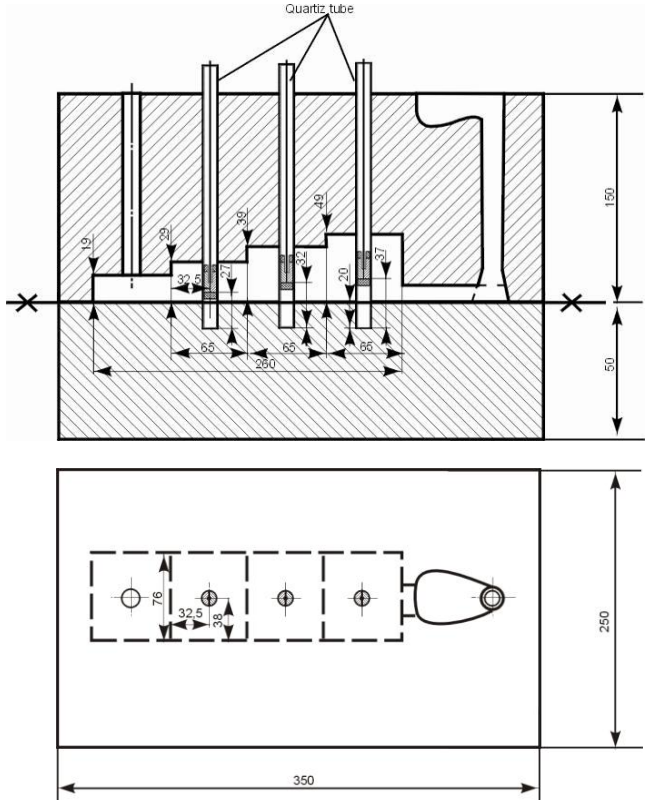

Fig. 3 The mould to scientific research

Research was done on different the mould was swamped by cast iron - $T_p = 1400^oC$.
As the purpose of the determine liquidus curves and the temperature change – install thermoelements (PtRh-Pt - diameter 0,5 mm) on the contact FeCrC and cast steel. Within the research observed existed structures at a misroscope light, as the purpose of the observation of phenomenon occured during be in the making surface composite layers.

Research started after an analysis of structural transformations of the high-carbon ferrochromium (contents carbon 9% i 65% chromium) – fig. 4. Concentration large chromium influences on rise liquidus temperature (peaceably from figs. 4). Near content from 8-10% carbon - liquidus temperature carries out 1700 ° C; solidus temperature 1530 ° C. Alloy contains (except 65% chromium and 9% carbon) 26% iron, what to influence on deforming three-phase arrangement and lowering solidus temperature. One accepted 1300^oC as solidus temperature and beginning of creation composite layer.

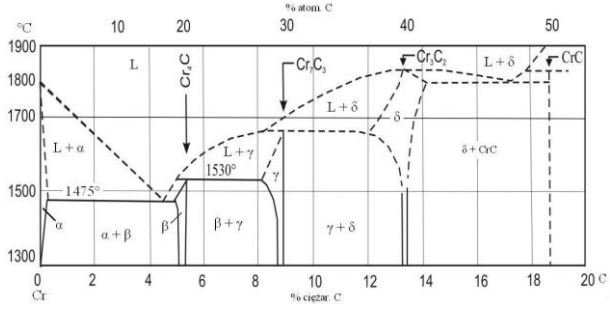

Fig. 4 The phase equilibrium system for alloy Cr-C [6,7]

3.3. Run Tests

Within the research was made test-pouring into mould liquid of cast iron $T_{pouring} = 1400^oC$. during the research was done registration of the temperature change in every samples – fig. 5.

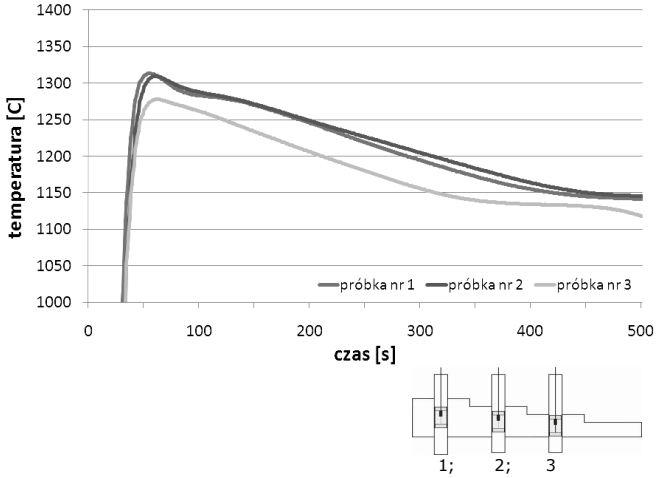

Fig. 5 Heating and self-cooling curves for individual sample

During the test gained too low temperature and time being above temperature 1300^oC at individual levels were to short to occur transport of mass.
In table 2 was shown maximum temperatures at each levels for certain test above temp. 1300^oC. A the gained structure for sample 1 (fig. 7) of the biggest heat capacity (fig. 6) is seen clear layer decarburization - started diffusion of carbon.

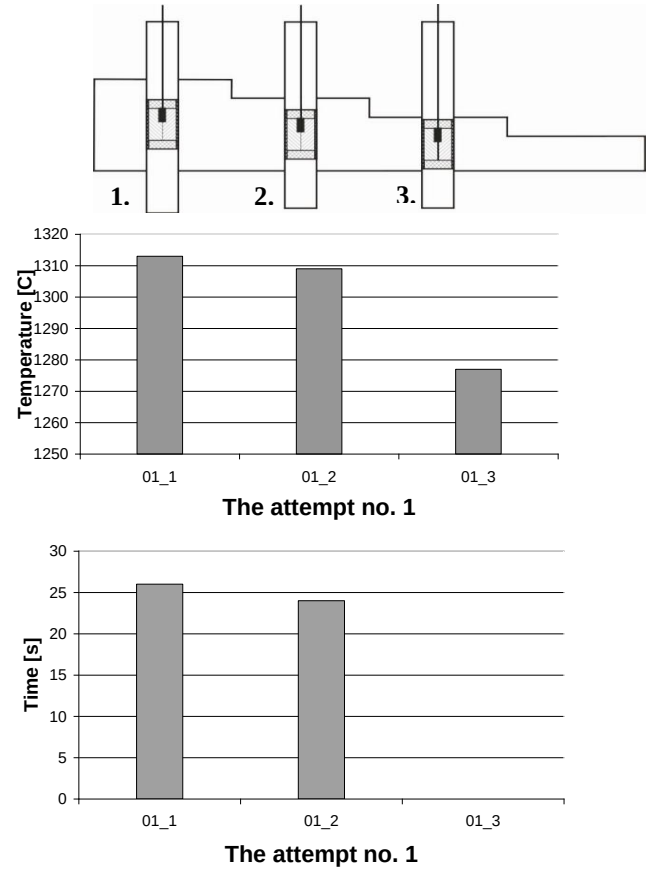

Fig. 6. The obtain results (a) maximum temperature and (b) stay time – sample higher up 1300^oC

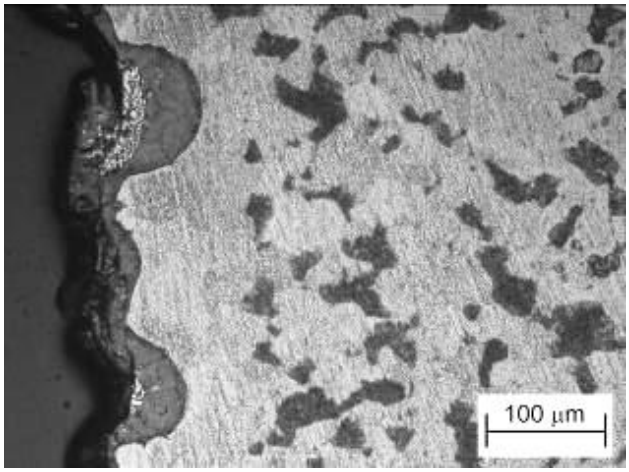

Fig. 7. Micrograph of sample; 01_1; zoom 200x

4. Conclusions

On the basis of conducted research, it can be certified that the surface composite layer forming process is influanced by the temperature and the time of being of jointed materials at the temp above 1300^0C.

Surface composite layer forming process requires intensive diffusion process (beetween grained ferrochromium and carbon cast steel)course. FeCr must attain temp above 1300^oC and stay at it for adequately long time.

The temperature of 1300^oC seems (according to phase equilibrium system for alloy Cr-C – fig. 4) to determine the beginning of cast layer forming process.

Tests showed:

- too short time (<26 s)of being of FeCrC above temp 1300^oC doesn't make surface cast layer forming process start
- too long time is not desirable because of full melting and mixing of components [9].

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