



Borocarburing of Construction Powder Metallurgy Materials of Fe - C - Cu System

K.Popov

Department of Machinery and Equipment
Technical University of Gabrovo
4, H. Dimitar str., Bulgaria

Abstract: *In this present researches is traced the formation and kinetics of growth in the boron-carbon diffusion layers on the powder metallurgical samples of Fe-C-Cu system. A bar graph of the phase changes in the surface layer of the saturated samples during different continuance of saturation is presented. The influence of the continuance of saturation over the thickness of the formed coating of samples with density 6,60g/cm³ is traced.*

Keywords: *thermo-chemical treatment, borocarburing, liquid areas, powder metallurgy, multi component diffusion*

I. Introduction

It is necessary the machine details and technological equipment together with high mechanical characteristics when operating in aggressive environment in many cases need to have high wear and corrosion resistance. Obtained by the method of powder metallurgy such products are complicated bulk doped which hinders the technological operations associated with their construction - pressing and sintering. Regarding this an essential scientific interest are the processes associated with surface multi component diffusion saturation of such details which matrix mainly consists of Fe-C powders and alloyed dopants relieving technology of manufacturing products. This type of alloyed dopant is copper. Unlike conventional metallurgical processes which, in practice, the copper is not applicable in powder metallurgy it is the main alloying element as it has significant advantages.

- could be prepared in the form of powder with different technologies.;
- received copper particles may be of various shapes;
- there is easily recoverable oxides;
- high plasticity that facilitates pressing;
- a lower melting point than Fe which determines the sintering in the presence of a liquid phase and etc.[3,4]

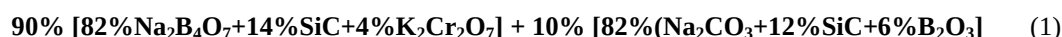
Regarding this the present researches objective is to study the formation and kinetics growth of the boron-carburizing diffusion layer on the powder metallurgical samples of Fe-C-Cu system.

II. Technical requirements

In the literature practically absent data for the borocarburing of powder metallurgy materials. Probably one of the reasons is the lack of a suitable environment for saturation that is consistent with the presence of surface and bulk porosity in powder metallurgy workpieces.

In recent years at the Technical University of Gabrovo were developed formulations for liquid boriding and carburization of construction powder metallurgy materials. [1,6,7,10]

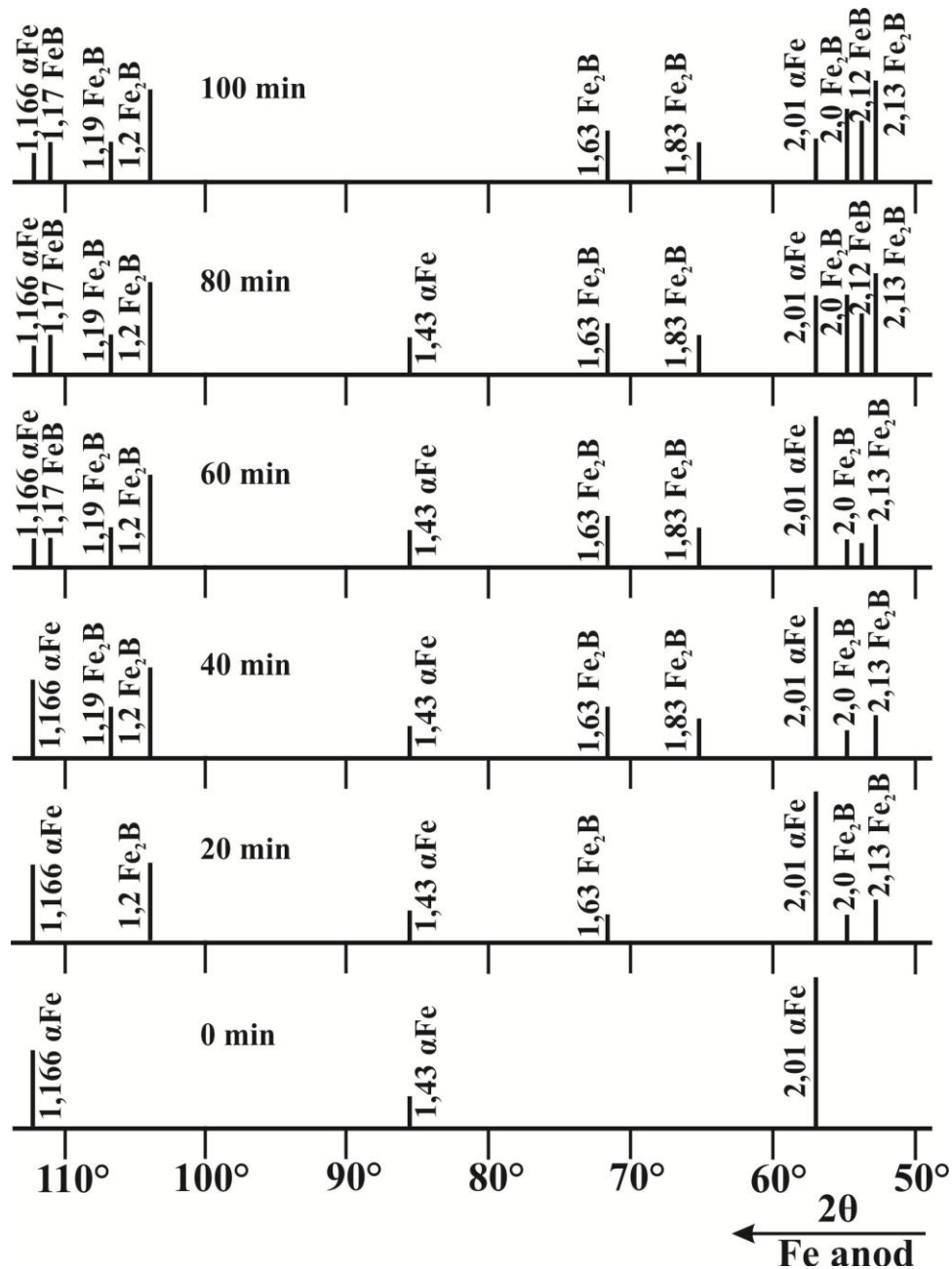
On their base was developed and optimized method adduced simplex lattices composition of boron-carburization in a liquid areas of powder construction materials – formula 1. [5,8]



The subject of this study are powder metallurgical samples based on iron powders ASC100.29. Towards them is added 0,5% graphite and 2,0% electrolytic copper. After mixing, the powders were pressed with force 400÷800MPa. This allows, after sintering at 1150C° under an atmosphere of dissociated ammonia for 30min to obtain samples with density of 5,90; 6,20; 6,60 and 7,00g/cm³.

Thus way formed samples are exposed on boron-carburizing of 950C° during 2, 3 and 4 hours in liquid saturating environment - formula 1.

Figure 1. X-ray analysis on a sample with density of 6,60g/cm³ after borocarburing in 950°C for 0 ÷ 100 min. in composition 1



From the literature it is known that the resistance of the borated products in aggressive and abrasive environments depends mainly on their phase composition formed in the process of saturation. [2,9] Essential in this case is a high boride phase - FeB, to not form a dense layer on the working surface of the workpiece. Based on a detailed X-ray analysis of the diffusion layers formed after saturation of the samples having a density of 6,60g/cm³ for 0÷100 min. is monitored sequence of formation and growth of the phases in consideration layers. First in the contact surface between the workpiece and the melt establishes a high concentration of boron atoms, which penetrate into the workpiece. This leads to a change in interferences maxima of Feα after the first 20 min. of saturation – Fig.1.

The figure shows that it does not fix the origin of the cementite phase – Fe₃C. This is explained by the fact that it has a low degree of symmetry and its practical determination by X-ray is quite difficult. Its presence in this case has been found by metallographic analysis.

After saturating for 20 min on X-ray images are fixed maxima of Fe_2B phase, but it peaks comparing them with those in boronizing and boron-aluminizing of the same samples at the same time and with all other equal conditions are significantly smaller.[3,6] This shows that the amount of Fe_2B in the surface layer in boron-carburization is less. This is explained with faster diffusion of carbon to boron in the austenitic matrix.

Increasing the time of saturation of 20 to 60 min did not result in a change in the phase composition of the diffusion layer. After saturating for 60 min, the concentration of boron atoms on the surface of the samples increased by up to an extent allowing the emergence and growth of the high boride phase – FeB .

Kinetics of growth and mechanism of formation of boron-carburized diffusion layers to saturation of powder samples of Fe – C - Cu system is directly dependent on many factors:

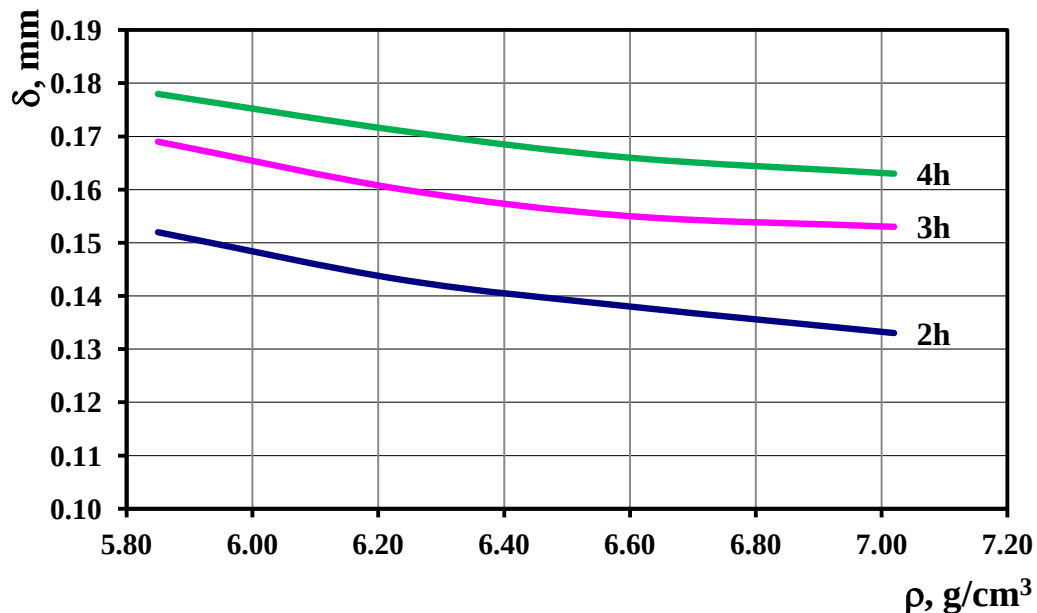
- temperature of saturation;
- duration of saturation;
- composition of the environment etc.

Them in powder metallurgical samples are added and the presence of pores – open and hided. All this shows that the formation of boron-carburized diffusion coatings is a complex technological process depending on a large group of external factors.

The kinetics of growth of the boro-carburizing layer depending on the density of the studied samples is presented to the Fig.2.

The figure shows that the highest values for the thickness of the diffusion coating is recorded in samples having a density of $5,80\text{g/cm}^3$, depending on the duration of the saturation ranges $145\div 175\mu\text{m}$. With increasing the density of the samples to $7,00\text{g/cm}^3$ the thickness of the formed coating decreases and depending on the duration of the process varies in the range $130\div 163\mu\text{m}$.

Figure 2. Kinetics of growth of the boro-carburizing layer depending on the density of the work pieces



III. Conclusion

From the conducted researches and obtained results could be presented the following conclusions:

- Formation and growth of the phase with boro-carburization of powder metallurgical workpieces of Fe-C-Cu system with density of $6,60\text{g/cm}^3$, containing 0,50% C and 2,0% Cu after saturation at 950°C for $0\div 100$ min. is monitored.
 - ✓ It was found that the nucleation of Fe_2B phase is formed on the surface of saturated samples after the first 20 min. of saturation.
 - ✓ High-boride phase – FeB register on the surface of the saturated samples after saturation for 60 min.
- Kinetics of growth of the boro-carburizing layers depending on the density of the samples and the duration of the saturation is monitored:
 - ✓ The increase in the density of the samples from $5,80$ to $7,00\text{ g/cm}^3$ reduces the thickness of the diffusion coating with $15\div 20\mu\text{m}$, as greater differences observed in the smaller duration of saturation.

- ✓ The increase in the retention time of the samples in the saturated area leads to an increase in the thickness of the diffusion layer with $25\div 30\mu\text{m}$, as larger values is fixed in samples with higher density – $7,00\text{ g/cm}^3$.

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