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The Solidification Study of the Antifriction Sn-Sb Alloy

The solidification study of the antifriction Sn-Sb alloy (HM07) cast on a steel bearing plate in order to obtain bimetallic bearings sized 330xΦ220 is presented in this paper, where the solidification study of the antifriction alloy is also reflected, using a corresponding simulation software (AnyCasting 10). The paper also contains, on the basis of pictograms regarding the solidification simulation study of the HM07 alloy and the metallographic structures realized on the component parts of the bearing and with the help of the electronic microscope and of the scanning electronic microscope, constructive conclusions for production are presented in order to help diminish losses of flaw castings.

Keywords: *bimetallic bearing, antifriction alloy, solidification simulation.*

1. Introduction

The idea of behaviours study during the exploitation of bimetallic bearings, obtained with the help of the centrifugal casting procedure, respectively of the functioning period, determined by the adherence of the Sn-Sb antifriction alloy (Whitemetal HM07) on a steel plate, started from the demands of producers/users that frequently observe a decrease in the exploitation time of these products, determined by the detachment of the antifriction alloy from the steel plate (rolled sheet).

Starting from new opportunities from the research domain that allow the investigation of alloy casting and solidification studies and the further study of metallographic structures, it was considered useful to continue the studies presented in papers [1], [3], [5] regarding the identification of causes that lead to a decrease in the functioning period in exploitation of these types of bearings as a result of a detachment of the antifriction alloy layer from the steel plate (slide plate).

If in paper [1], the authors approached this aspect from the point of view of microalloying of the Sn-Sb antifriction alloy; in this paper the authors have approached the problem of antifriction adhesion of the alloy on the steel plate from the perspective of casting and cooling temperatures, with the help AnyCasting simulation software [4].

The AnyCasting software was used to study the characteristics and the phenomena that appear during the solidification of the antifriction alloy, cast on a steel plate in order to produce a bearing sized 330xΦ220. In order to realize bimetallic bearings, specific technological operations to prepare the steel plates were used and which are represented by the careful cleaning of the active surface of the plate through: sanding, cool washing or perchlorethylene wiping and the corresponding preparing before tinning. The preparing of the steel plate is represented by its covering with a thin and uniform layer (5-10 mm) of a solid mixture of ammonium and zinc chloride with a rate of 1:2.

Before the tinning operation of the plate, it is warmed up in a drying furnace, at a temperature of 250ºC (temperature inside the furnace); a temperature which is maintained for 2 hours in order to obtained the drying of the plate. During this period, the slide plate temperature reaches 350-400ºC. The following process is represented by the tinning of the steel plate. This operation can be realized using two variants: by rubbing the surface with a tin rod (in two steps) or by sinking it in a tin bath (a technology frequently applied in the industrial practice. The tinning operation is applied only after the active surface of the steel has been cleaned of salts scrap.

The casting process of the antifriction alloy is realized in conditions represented by steel plate temperature of 250ºC.

Tables 1 and 2 present the chemical compositions of the antifriction alloy and of the steel plate.

Table 1. Chemical composition of the antifriction alloy (Whitemetal HM07) [%]

Sb	Pb	Cd	Ni	Cu	Sn
6.25	0.06	0.23	0.11	5.7	Scrap

Table 2. Chemical composition of the steel plate [%]

C	Si	Mn	S	P	Fe
0.22	0.25	0.48	0.015	0.03	Scrap

2. The casting and the solidification study

This part of the paper presented the casting and the solidification study of the Sn-Sb antifriction alloy (Whitemetal HM07) with the help of the AnyCasting 10 software. The study is based on following the casting temperatures during the casting and the solidification periods for the antifriction alloy, in the antifriction alloy cast on the plate and at the interface antifriction alloy - steel plate.

Figures 1÷9 present the aspects regarding the temperature evolution in the antifriction alloy layer, in the bimetallic bearing (antifriction alloy + slide plate) and at the antifriction alloy - plate interface, and figure 10 presents only the temperatures level in the bearing.

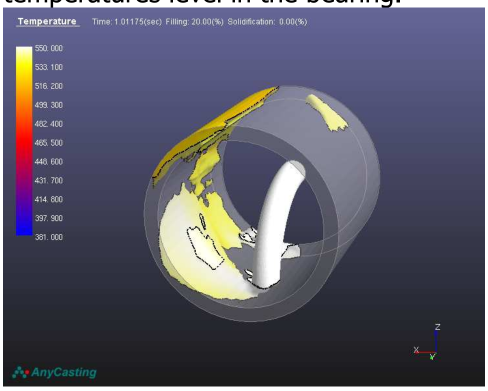

Figure 1. Temperature distribution in the antifriction alloy after 1.0 sec., from the beginning of the casting process; filling: 20%

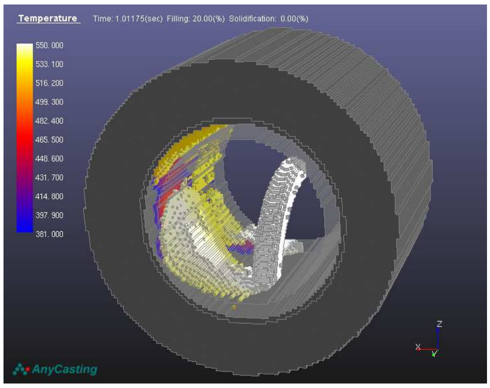

Figure 2. Temperature distribution in the antifriction alloy, cast on a steel plate, after 1.0 sec., from the beginning of the casting process; filling: 20%

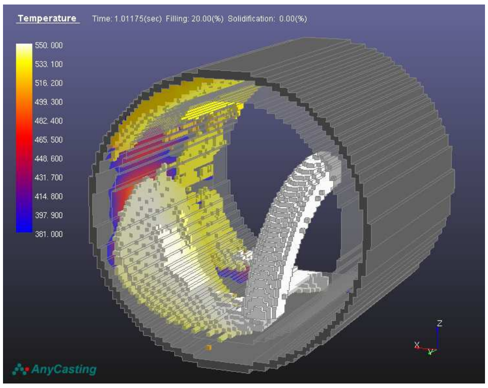

Figure 3. Temperature distribution on the antifriction alloy - plate interface, after 1.0 sec., from the beginning of the casting process; filling: 20%

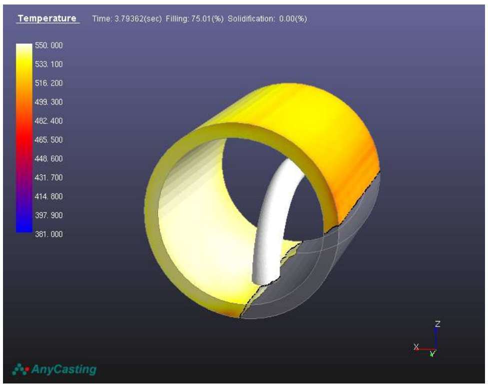

Figure 4. Temperature distribution in the antifriction alloy, after 3.8 sec. from the beginning of the casting process; filling: 75%

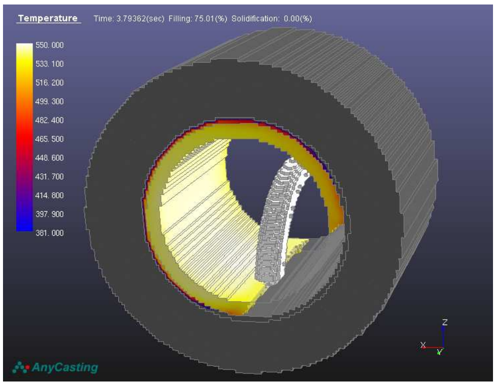

Figure 5. Temperature distribution in the antifriction alloy, cast on a steel plate, after 3.8 sec., from the beginning of the casting process; filling: 75%

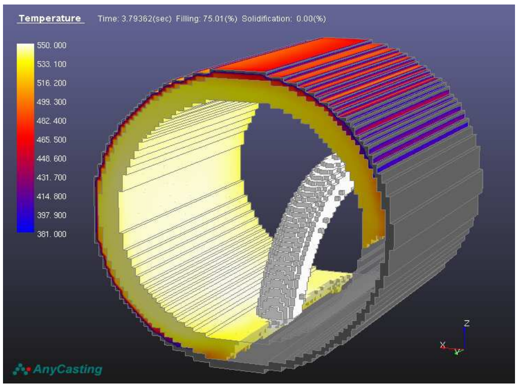

Figure 6. Temperature distribution on the antifriction alloy - plate interface, after 3.8 sec., from the beginning of the casting process; filling: 75%

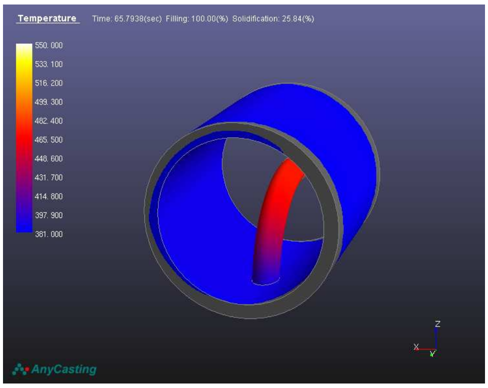

Figure 7. Temperature distribution only in the antifriction alloy, after ~ 66 sec., from the beginning of the casting process; filling: 100%; solidification: ~26%

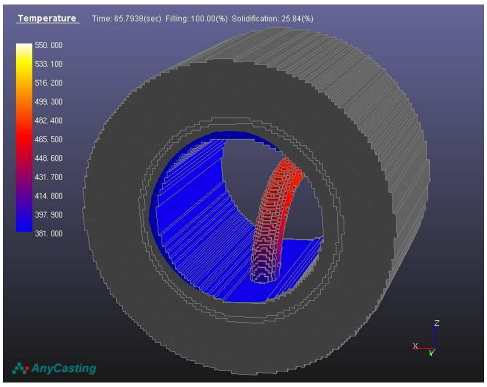

Figure 8 Temperature distribution in the antifriction alloy, cast on a steel plate, after 66 sec., from the beginning of the casting process; filling 100%; solidification: ~26%

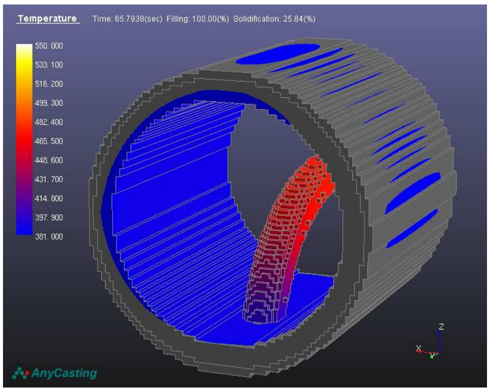

Figure 9. Temperature distribution on the antifriction alloy – plate interface, after ~66 sec., from the beginning of the casting process; filling of 100%; solidification: ~26%

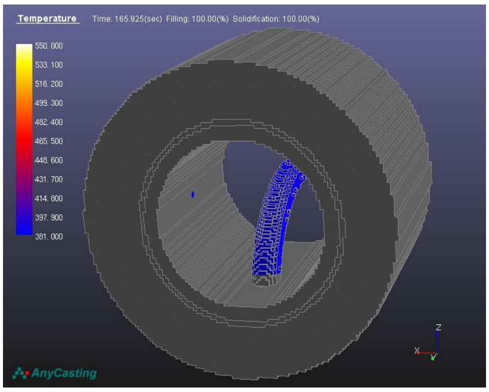

Figure 10 Temperature distribution in the antifriction alloy, cast on a steel plate, after 166 sec., from the beginning of the casting process; solidification100%

3. Metallographic structures

Figures 11÷13 present the metallographic structures realized on the antifriction alloy layer, on a steel plate and at the antifriction alloy – steel plate interface. The structures were realized with an optic microscope.

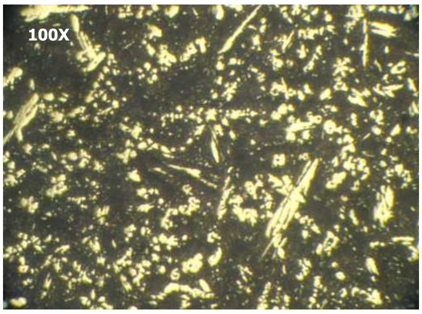

Figure 11. Metallographic structure of the HM07 antifriction alloy

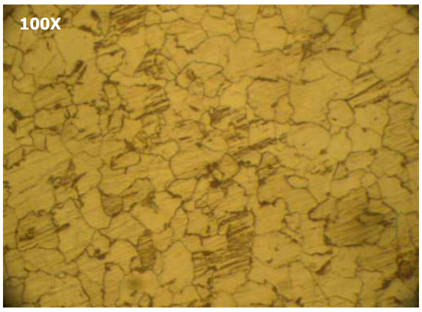

Figure 12. Steel plate metallographic structure

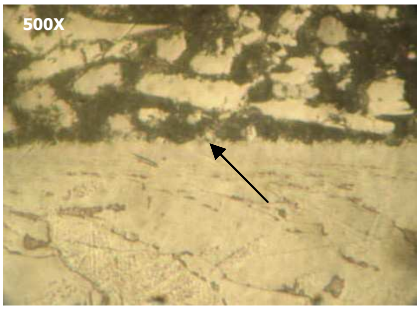

Figure 13. Metallographic structure antifriction alloy – steel plate interface

The study of microstructures, realized with an optic microscope, highlight the following aspects regarding materials that form the bimetallic bearing: the structure of the Sn-Sb antifriction alloy contains geometrical and fine crystals of Cu_6Sn_5 compound, which are dispersed in a solid solution α (Sn) matrix; the microstructure of the steel slide plate is characterized by a ferrite-pearlitic polyhedral matrix at the antifriction alloy – steel slide plate interface; interruptions of the tin layer are also observed (see "arrow" from figure 13).

Figures 14÷15 present the microstructures obtained at the antifriction alloy - steel plate interface layer, with a scanning electronic microscope.

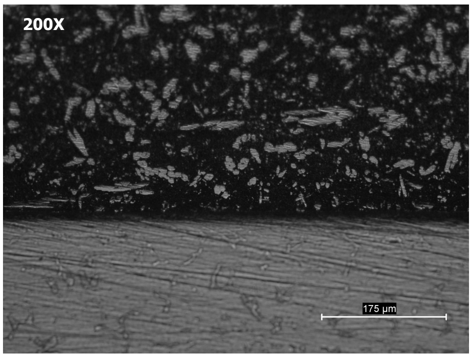

Figure 14. Bearing microstructurse at the HM07 alloy - steel slide plate interface

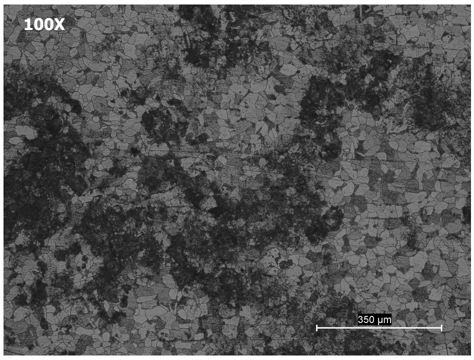

Figure 15. Microstructure of the steel slide plate at the HM07 alloy - steel slide plate interface

The study of microstructures presented in figures 14÷15 realized with an electronic microscope highlight the fact that the tin layer from the slide plate interface is not completely vaporized when entering in contact to the antifriction alloy layer, as a result of its temperature or of that of the slide, but only on certain sectors which usually presented flaws (oxide crusts type) and which influence in a negative manner the tin adherence.

4. Conclusion

The study of casting and solidification temperatures of the antifriction ally cast on a steel plate, previously prepared for the execution of the bimetallic bearing shows that indeed, its casting temperature may lead to an evaporation of the tin layer from the surface of the steel slide plate.

The presence of copper in the composition reduces the segregation tendency of the SnSb phase during solidification.

In the structures of the HM07 antifriction alloys no separations of Cu_2Sb rough intermetallic compounds and no Pb-Sb eutectic compounds were observed.

The structure study of HM07 antifriction alloys highlight dendritic, point like and fine segregations of Cu_6Sn_5 intermetallic compound, in a matrix of α solid solution (tin).

The microstructure of steel plates (slide plates) is characterized by a ferrite-pearlitic matrix (in general polyhedral).

The tin interruptions at the HM07 alloy – steel slide plate interface can be a cause of the casting temperature and of the existence of surface flaws (oxide crusts) on the contact interface of the slide plate with the HM07 alloy layer.

The existence of such flaws cause by an incorrect preparation of the slide surface, but also by the prolonged keeping of the slide on the field before the casting of the antifriction alloy reduce in a significant manner the functioning duration of bearings.

In these conditions, even a microalloying with cadmium is used for the antifriction alloy, no increase of adherence is obtained on the steel plate.

References

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