STRUCTURE OF PHOSPHOR TIN BRONZE CuSn10P MODIFIED WITH MIXTURE OF MICROADDITIVES

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ABSTRACT

Research on the modification of CuSn10P tin bronze with a zirconium additive revealed the advantageous influence of that reagent on the microstructure of the alloy. The effectiveness of the Zr influence was additionally improved by Mg and Fe microadditives. The modification process caused also the structure refinement.

Keywords: modification, crystallization, phosphor-tin bronze, microstructure

1. INTRODUCTION

Phosphor tin bronze CuSn10P is characterized by good tensile strength (350-430 MPa), proper hardness, corrosion and abrasion resistance, as well as resistance to high mechanical load. This material have also good castability and machinability. Due to its advantageous properties the phosphor tin bronze is widely for high-load, high speed, poorly lubricated and exposed to corrosion bearings, and in casting of machine engines components as well as chemical armature. The structure and properties of alloy depend on melting and casting conditions, which influences the alloy crystallization [1]. The improvement of alloy structure is crucial for alloy properties. In this paper studies on the influence of modification of bronze CuSn10P on its structure are described. The results of investigations on modification of copper alloys [2,3] have shown the advantageous effect of zirconium on modification of bronzes. Moreover, the microadditives of magnesium and iron enhanced significantly the positive effect of

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Zirconium in the modification of bronzes. Iron stimulates the processes of heterogeneous nucleation. Magnesium prevents the oxidation of zirconium in liquid metal.

2. EXPERIMENTAL

Commercial phosphorus tin bronze CuSn10P was used in the investigations. The melting and the modification treatment were performed in the inductive furnace IMSL – 10. The ceramic-graphite crucibles with isolating coating were applied. As the modification agents the zirconium and mixtures of zirconium with magnesium and iron were used. Zirconium was introduced into the molten metal as the CuZr35 master metal, whereas magnesium and iron as the elements. The modification treatments were carried out on molten metal being overheated to the temperature 1423K and covered by the protective salt melt. The modified metal was further kept in liquid state in crucible inside the furnace [4].

The following heats were performed: a) without modification for 2min, b) with modification by 0.04% Zr for 2 min, c) with modification by mixture of microadditives: 0.02% Mg + 0.02%, Fe + 0.04 % Zr for 2 min, d) with modification by mixture of microadditives: 0.02% Mg + 0.02% Fe + 0.04 % Zr for 60min.

Test specimens for structure evaluation were cast to metallic forms. Specimens of the un-modified bronze and bronze modified with zirconium were cast after 2 minutes, whereas bronze specimens modified with mixture of microadditives after 2 and 60 minutes.

3. INVESTIGATION OF STRUCTURE

Structures of unetched samples of the alloy were observed and analyzed with the electron microscope scanning JSM – 5600 with EDS – 2000 facilities. Microstructures of bronze CuSn10P are shown in Fig. 1 and 2.

Unmodified bronze shows well developed dendrites of α-phase. The dendritic structure of α-phase was also present in bronze modified by 0.04 % Zr. The modification with mixture of microadditives suppresses the dendritic α-phase formation in alloy cast even as late as 60 minutes after modification.

In the unmodified alloy the eutecticum α+δ+Cu3P is irregularly disposed in the interdendritic structure of bronze. The structures of samples modified with the microadditives of zirconium, magnesium and iron characterize by the refinement of dendrites of α-phase as well as the precipitation of eutecticum α+δ+Cu3P evenly disposed in the interdendritic space [5,6], even when the metals is being cast 60 minutes after modification.
In order to examine the influence of modification on the structure of bronze, the qualitative and quantitative analysis of the selected micro areas of samples (magnification ×200), was performed. The results of investigations, presented as the energy spectra and the concentration of elements, are shown in Fig 3 a, b, c, d. and table 1.

Tabela 1. Zawartość procentowa pierwiastków w próbkach po wytopie
Table 1. Concentration of elements in samples

<table>
<thead>
<tr>
<th>Nr melt</th>
<th>%Cu</th>
<th>%Sn</th>
<th>%P</th>
<th>%Zr</th>
<th>%Fe</th>
<th>%Pb</th>
<th>%Mn</th>
<th>%Ni</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) without modification – 2 min.</td>
<td>88.0</td>
<td>10.1</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>0.7</td>
<td>-</td>
<td>0.15</td>
</tr>
<tr>
<td>b) 0.04% Zr – 2 min.</td>
<td>87.6</td>
<td>10.8</td>
<td>0.9</td>
<td>0.046</td>
<td>0.011</td>
<td>-</td>
<td>0.13</td>
<td>-</td>
</tr>
<tr>
<td>c) 0.04% Zr + 0.02% Mg + 0.02% Fe – 2 min.</td>
<td>87.9</td>
<td>10.4</td>
<td>0.99</td>
<td>0.048</td>
<td>0.022</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>d) 0.04% Zr + 0.02% Mg + 0.02% Fe – 60 min.</td>
<td>86.8</td>
<td>11.89</td>
<td>1.13</td>
<td>0.014</td>
<td>0.005</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

In unmodified bronze lead and nickel are present, whereas in the alloy modified with zirconium iron and manganese are being found, probably as impurities. In samples
modified with mixture of microadditives the introduced zirconium and iron are present, although their concentrations drop down 4 times in 60 minutes after modification in comparison to the concentrations of these elements 2 minutes after modification. Not observed magnesium, which was not found in samples was very likely oxidized.

Fig. 2. Microstructure CuSn10P (magnification ×2000): a) without modification, b) 0.04% Zr - 2min, c) 0.04% Zr + po 0.02% Mg i Fe - 2min, d) 0.04% Zr + po 0.02% Mg i Fe - 60min.
For samples of unmodified alloy (×2000) the analysis of the distribution of the components of the alloy Cu, Sn and P was made and its result presented in Fig. 4.

4. CONCLUSIONS

The modification mixture of 0.04 % Zr, 0.02 % Mg and 0.02 % Fe causes the advantageous grain refinement of structure of CuSn10P. The effect of modification lasts as long as 60 minutes after the treatment.

REFERENCES

Badania nad modyfikacją brązu cynowo-fosforowego CuSn10P mikrododatkiem cyrkonu wykazały korzystny wpływ na mikrostrukturę stopu. Poprawę efektywności wpływu cyrkonu zbadano wprowadzając ponadto mikrododatki magnezu i żelaza. Modyfikacja mieszaniną mikrododatków spowodowała rozdrobnienie struktury brązu CuSn10P, które utrzymuje się 60 minut po zabiegu modyfikacji.

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