MECHANICAL PROPERTIES AND MICROSTRUCTURE OF
Zn - Al - Cu ALLOYS

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Mechanical parameters of cast Zn-Al-Cu alloys have been studied under tensile load.Regression equations of relationship with Al and Cu concentrations have been derived.Mechanical properties have been explained by morphological features of microstructure and composition of phases.

INTRODUCTION

Zinc alloys containing aluminium and copper show different physical and mechanical properties depending on the level of alloying- Johnen (1),(2) . The goals of our investigations is to establish quantitative relations between the values of the mechanical parameters and alloying elements concentrations as well as to define the regions showing optimal properties and microstructure.

EXPERIMENTAL TECHNICS

Sixteen cast alloys of Zn2Al-Cu system have been studied. Aluminium concentration in alloys has been varied to levels of 5, 13, 27 and 35wt% and for each of those levels the copper concentration has been changed in accordance with the scheme 1, 5, 11 and 15 wt%.

Phase compositions and microstructure of the alloys have been inve-

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stigated by X-ray microanalysis and scanning electron microscopy (reflected electrons contrast),figure 1, Kamenova et al (4), (5).

After a 250 days period of ageing at ambient temperature the specimens have been subjected to uniaxial tensile loads. The values of basic mechanical parameters σ_{TS}, σ_{YS}, A5 and HB have been determined.

RESULTS AND DISCUSSION

Experimental date obtained for σ_{TS}, σ_{YS}, A5 and HB have been statistically processed by means of a model with a complete polynomial of the 3d degree, Hartmann (3).As a result,the following regression equations describing the variation of mechanical parameters values as a function of alloying elements concentration C(Al) and C(Cu) have been obtained:

$$\sigma_{TS} = 46,66 + 1,56A - 0,69B - 3,32AB - 5,53A^2 - 6,78B^2 + 3,37A^2B - 2,44AB^2 + 3,28A^3 + 0,91B^3 \quad (1)$$

$$\sigma_{YS} = 39,31 + 3,04A + 5,29B - 3,13AB - 4,56A^2 - 2,93B^2 + 1,64A^2B - 3,84AB^2 + 3,09A^3 + 2,66B^3 \quad (2)$$

$$A5 = 4,79 - 0,20A - 7,45B - 0,25AB - 0,28A^2 - 2,83B^2 + 1,03A^2B + 0,23AB^2 - 0,14A^3 + 5,63B^3 \quad (3)$$

$$HB = 138,47 + 5,91A + 12,56B - 0,37AB - 4,56A^2 + 3,25B^2 + 5,69A^2B + 2,34AB^2 - 0,74A^3 + 9,79B^3 \quad (4)$$

where A=(C(Al)- 20) / 15 and B=(C(Cu)-8) / 7. Values of the multiple correlation coefficients are: R(σ_{TS})=0,98, R(σ_{YS})=0,99, R(A5)= 0.95 and R(HB)=0,97 .

Maximum values of alloy strength parameters within the concentration range of 13 to 27 wt% of Al and 5 to 11 wt% can be explained by the following microstructural features:

- formation of homogenously dispersed precipitation products of the primarily crystallized α-phase (solid solution of Zn in Al) and the peritectically formed β-phase(ZnAL)

-highest level of Cu in α- and β-phases (up to 6wt%),(5)

-absence of coarse and anisotropically oriented phases

- ε (Zn4.6Cu0.9Al0.1) and T (Al5.3Cu3.8Zn1) phases precipitated in dendritic spaces,form disperse eutectic net.

In the alloys with maximum Cu concentration a decrease has been observed of and values as a result of the precipitation of coarse copper containing phase δ(Cu2.3 Zn7.1 Al 0.6) and T-phase with unfavorable shape.

This is also the reason for decrease of amount of copper dissolved in α- and β -phase (below 5wt%),(5).

Alloys containing 5 wt% of Cu and 13 to 27wt % Al posess the highest plasticity.No coarse phases are observed in their microstructures. ε-phase amount in the dendritic space is comparatively small and α- and β-phases contain relatively low quantity of Cu (below 3wt%),(5).

The high hardness values characterizing the alloys of the highest Al and Cu content are due to the great amount of precipitated phases,uniform distribution of the eutectics as well as to the high Cu concentration in α - and β -phases (up to 4 wt%),(5).

SYMBOLS USED

A5 - plasticity determined by relative elongation,%
HB - Brinell hardness (on the basis of 2,5/31,25/30)

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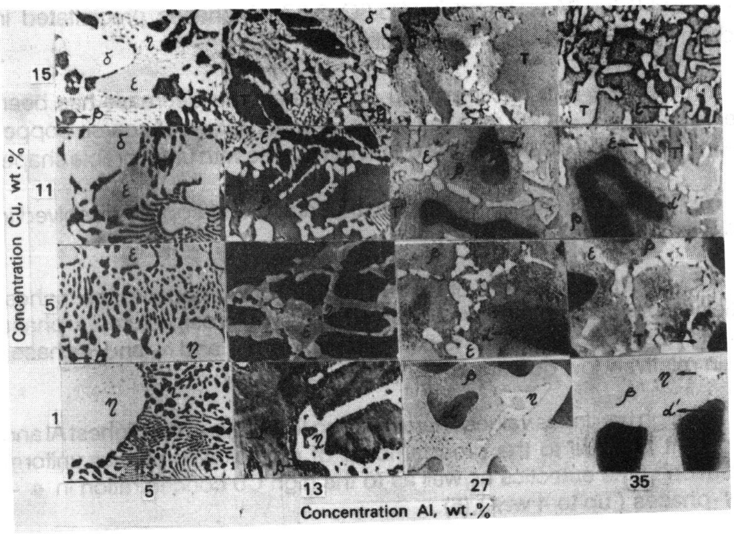

Fig.1. Microstructure 5 nm

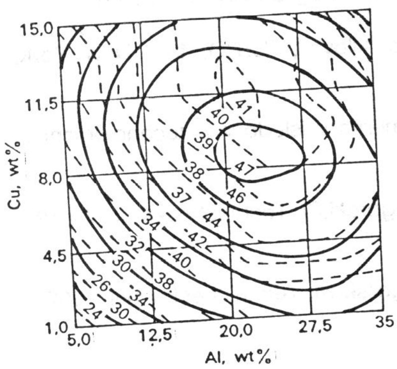

Fig.2. Alteration of σ_{TS} (——) and σ_{YS} (-----) x10^{-1} MPa

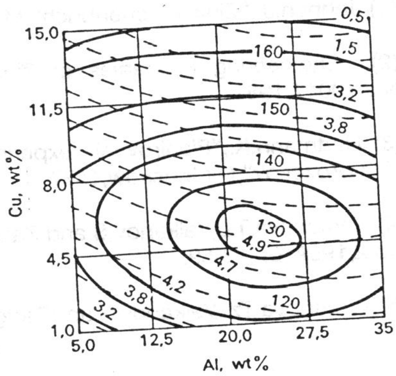

Fig.3. Alteratoin of A5 % (——) and HB, MPa (-----)