UDC 669.721.5

V.A. Shalomeev, associate professor, d.t.s.

# INFLUENCE OF FORM AND SIZES FOR INTEMETALLIC COMPOUNDS ON PROPERTIES OF MAGNESIUM CASTING

*Zaporozhe national technical university, Ukraine*

The influence of alloying elements at the form and size of intermetallic compounds in a magnesium alloy has been showed. The quantitative and qualitative evaluation of intermetallic phases in the alloy MC5, alloyed by Nd, Ge, Ag, Si, Y, Sc, Zr, Ti and Hf has been realized, its influence at the structure, mechanical properties and hot resistance of magnesium casting has been investigated.

Keywords: alloying element, intermetallic compound, structure, mechanical properties, hot resistance, dimensional group, the volume percent.

Constantly increasing demands to the modern technique are stipulated by the necessity of creation of light alloys, providing higher mechanical properties and sufficient reliability against destruction at higher temperatures [1]. Last years a large attention is given to the study of influence of different structural factors on mechanical properties and hot-resistance of the responsible cast details from magnesium alloys [2]. Alloying elements, co-operating with magnesium, form intermetallic compounds, which influence on a structure and properties of the cast metal [3].

The purpose of researches is an estimation of influence for number of alloying elements (*Nd*, *Ge*, *Ag*, *Si*, *Y*, *Sc*, *Zr*, *Ti* and *Hf*) on a form and size of appearing intermetallic phases in the alloy of MC5, and similarly their influence on a structure and properties of the magnesium casting.

The magnesium alloy of MC5 was smelted in induction crucible and distributing furnaces. In fusion have entered the increasing additives of ligatures of corresponding elements (0; 0.05; 0.10; 1.0 %), it is warmed up him and inundated samples with diameter 12.0 mm which exposed to heat treatment on T6 regime.

Mechanical properties and hot-resistance of samples were determined on standard methods. The metallographic analysis of the investigated alloys was executed by means of microscopes of «Neophot 32» and «OLYMPUS IX 70». The microreontgenspectrum analysis of structural constituents of magnesium alloys was executed on the electronic microscope of «JSM-6360LA».

A microstructure of alloy of MC5 was δ-solid solution with the presence of eutectic of type δ+γ($Mg_{17}Al_{12}$) and intermetallic γ($Mg_{17}Al_{12}$). Itermetallic phase was both spherical form, being situated into grains and lamellar form – on the borders of grains. On results of microreontgenspectrum analysis spherical intermetallic compounds are contained ~80 % *Mg*, ~15 % *Al* and additionally *Si* and *Mn*, lamellar intermetallic compounds had composition ~60 % *Mg* and ~40 % *Al*.

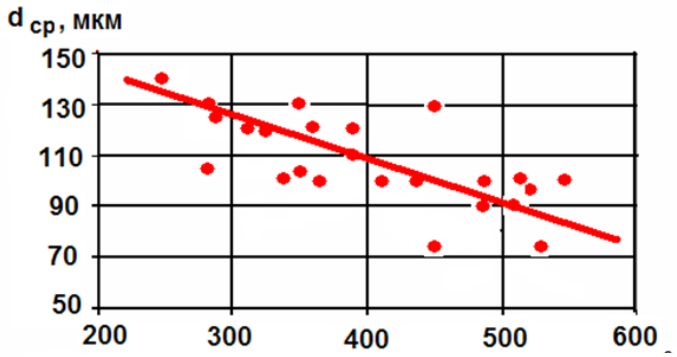
Introduction of alloying elements to the alloy to the promote increase of by volume stake of intermetallic phase, here, increase of their content to 1.0 % increases

the amount of intermetallic in 1.5 time. A presence is set in the structure of the investigated alloys, both lamellar and spherical intermetallic phases, enriched by corresponding alloying elements.

At content in the alloy of alloying elements in an amount 0.05…0.10 % intensively the by volume stake of spherical intermetallic is increased and lamellar intermetallic is insignificantly. The analysis of distribution of intermetallic compounds showed on size groups, that lamellar intermetallic compounds prevailed in an initial alloy, majority from which were in the size group of 4-15 mcm. Spherical intermetallic compounds, mainly, presented by the size group of 2.0-7.9 mcm. In a magnesium alloy the investigated alloying elements is grinded intermetallic phase, and her distribution was displaced toward less size groups. Thus, the increase of content of alloying elements in an alloy increased volume part of intermetallic compounds with the sizes < 2 mcm and diminished volume part of large intermetallic compounds with the sizes > 11,6 mcm. Thus, dependence (fig. 1) it is set, when with the increase of volume percent of intermetallic compounds at the increase of content of elements in the alloy of MC5 microgrit was notedly ground down:

$$d_{mid} = 180{,}52 - 0{,}18\,V\,; \quad r = -\,0{,}82,$$

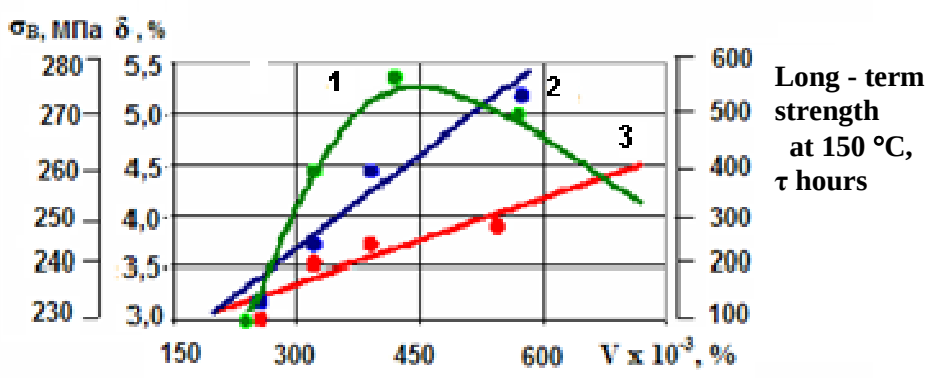
where $d_{mid}$ is a middle diameter of microgrit, mcm; $V$ is a volume part of intermetallic compounds in an alloy; $r$ is a coefficient of correlation.




**Picture 1** – Influence of by volume part of intermetallic ($V$) at the size of microgrit ($d_{mid}$) in the alloy of MC5

Durability and hot-resistance of the alloyed magnesium alloy of MC5 rose with the increase of by volume part of intermetallic compounds. Intermetallic compounds, being situated in the center of grain and on his borders, consolidated an alloy and promoted his hot-resistance (fig. 2). Plasticity of alloy depending at the amount of intermetallic compounds had nonlinear dependence.

Quantity of the distinguished intermetallic phase and also her morphology and topology had influence on properties of magnesium alloy.




**Picture 2** – Influence of volume percent of intermetallic on properties of alloy of MC5 with *Sc*

Lamellar intermetallic compounds by size to 8.0 mcm positively influenced on properties of alloy, spherical – only to the size of 11.6 mcm. It is set that on work-hardening of alloy greater influence was rendered by spherical intermetallic compounds of less size groups. The increase of plasticity of alloy was observed only at introduction of the investigated elements in at quantity 0,05-0,10 %. At the further increase of content of elements in an alloy (to 1.0 %) simultaneously with growing of microgrit shallow there is a substantial height of volume part of intermetallic compounds, that results to the embitterment of metal and decline of the relative lengthening.

## LIST OF LITERATURE

1. Садков, В. В. Применение Mg-сплавов в самолетах ОАО «Туполев» [Текст] / В. В. Садков, О. П. Авдеева, В. П. Агеев // Металлургия машиностроения. – 2006. – № 1. – С. 11-14.
2. Шаломєєв, В. А. Нові магнієві сплави з підвищеними властивостями для авіаційних двигунів [Текст] / В. А. Шаломєєв, Е. І. Цивірко, Ю. О. Зеленюк // Вісник двигунобудування. – 2012. – № 1. – С. 218-223.
3. Рейнор, Г. В. Металловедение магния и его сплавов [Текст] / Г. В. Рейнор. – М. : Металлургия, 1964. – 486 с. – Библиогр.: с. 475-476.