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ČASOPIS PRE TEÓRIU A PRAX MECHANICKÝCH TECHNOLÓGIÍ

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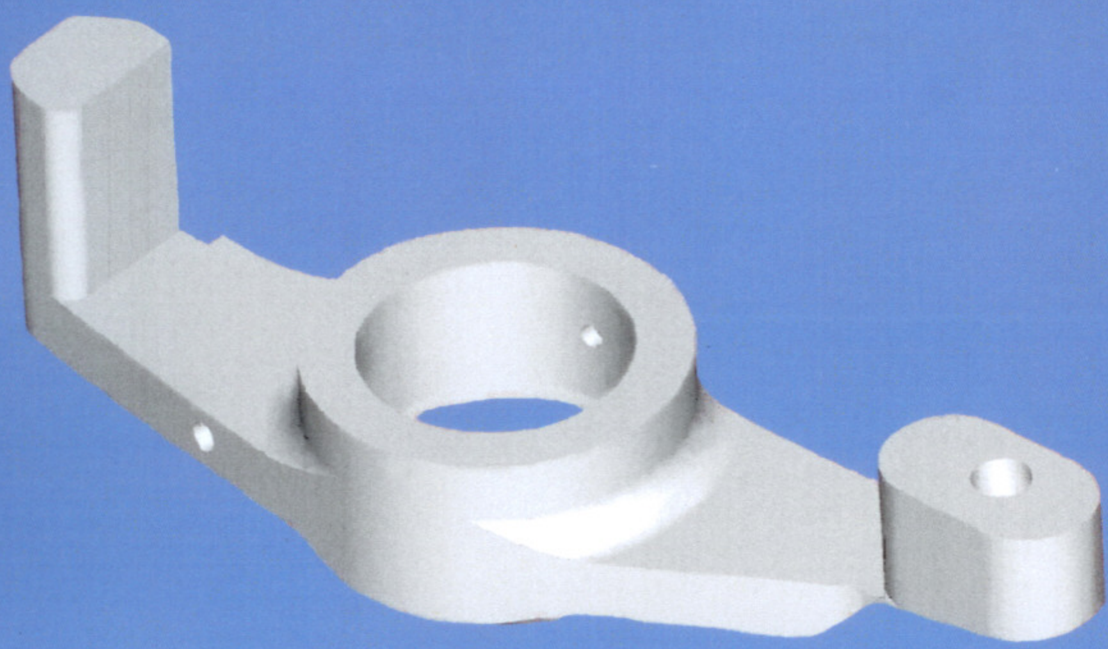

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PROPERTIES vs. FINENESS of STRUCTURE OF SAND CAST Al-Zn20 ALLOY

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Abstract: The paper brings information about grain refinement of the Al – 20 wt% Zn (AlZn20) foundry alloys, developed in frame of the Marie Curie Transfer of Knowledge EU project CastModel.
The work comprises the use of traditional AlTi5B1 and AlTi3C0.15 refiners and the elaborated new one, based on the Al – Zn - Ti system. The paper brings information about performance and efficiency of the master alloys used during the examinations as well as changes of the macrostructure fineness linked with changes of strength and damping properties of the examined alloy.

INTRODUCTION

Energy saving and environmental protection are, among others, the two important priorities of the European Community programs. Hence, development of new alloys for foundry industry should focus on the less energy-consumable ones. The aluminium-based cast alloys with increased zinc content can answer mentioned above demands. These alloys have low melting temperatures, very good dumping properties and good strength. However, in sand mould they built coarse dendritic structure of lowered elongation and that is why they require grain-refining to improve their plastic properties.
The technology of the Al alloys refinement commonly uses Al-Ti-B (TiBAl) and Al-Ti-C (TiCAl) master alloys, which are known as very effective refiners. Recently, new alternative master alloys based on the Zn-Ti system were elaborated. The latter show quick dissolution in a melt temperature as low as about 500°C, which allow avoiding detrimental overheating, reducing the costs of energy and material [1].
The present work describes efficiency of the Al-5 wt%Ti-1 wt% B (AlTi5B1; TiBAl), Al-3 wt% Ti – 0.15 wt% C (AlTi3C0.15; TiCAl) and (Al,Zn)-3 wt% Ti (AlZn-Ti3) master alloys used as grain refiners of the sand cast Al-20 wt% Zn (AlZn20) alloy. The observed increase of grain populations was also linked to the changes of ultimate tensile strength and elongation.

EXPERIMENTAL

The examined alloy AlZn20 and the master alloy AlZn-Ti3 were laboratory prepared and melted from electrolytic aluminium (minimum purity 99.96%); electrolytic zinc (99.995%) and titanium sponge (98-99.8%, from Johnson Matthey Alfa). The melting was performed in an electric resistance furnace, in an alumina crucible of 1 litre capacity. The AlZn20 melt was superheated to ~720°C, then a master alloy was added and the melt was left for 2 minutes. Then the melt was being stirred for next 2 minutes with an alumina rod, and finally the alloy was cast into a dried sand moulds to obtain dog-bone shape samples (working part ∅12x60 mm) for tensile tests and ∅32x50 mm samples for damping tests. To monitor the melting process thermocouples NiCr-NiAl0.5 ∅0.20 mm were used. Temperatures (accuracy ± 1°C) were recorded using a multi-channel recorder Agilent 34970A (Agilent Technologies Inc., USA). Microsections for LM examinations were ground on abrasive paper (grit 200-1000) and then were polished using sub-microscopic aluminium oxide in water-alcohol suspension.

The AlZn20 samples, used in macrostructure examinations, were etched with Keller's or Barker's reagent. LM observations of microstructures were performed using Leica-DM IRM microscope. The tensile tests were performed using an Instron 3308 device.

RESULTS

Examples of the initial structure of the examined ZnAl20 alloy are shown in Figs 1 and 2. There are visible coarse branched dendrites of the α (Al) phase (solid solution of Zn in Al).

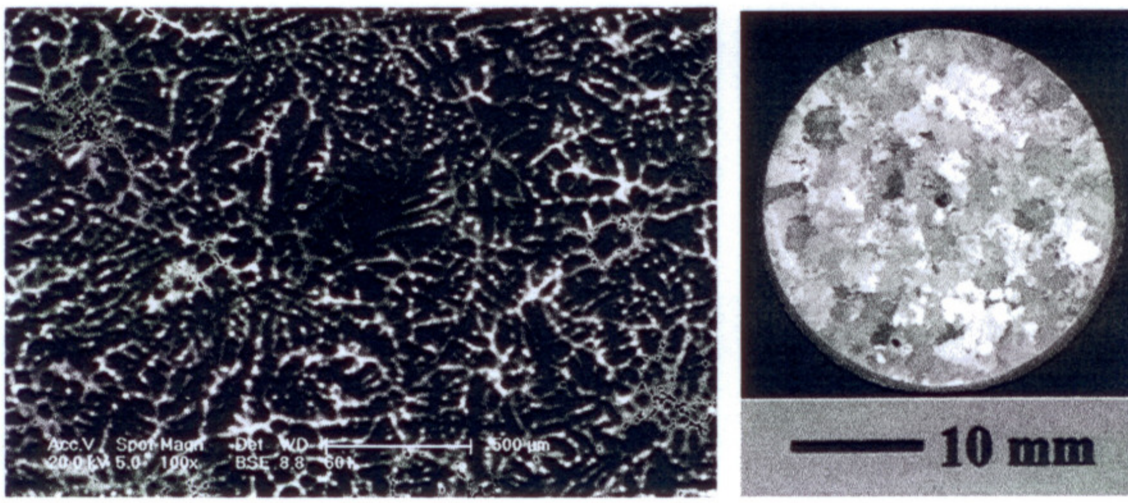


Fig. 1 *Microstructure and macrostructure of the sand cast initial, non refined AlZn20 alloy. Mean grain size 1800 μm*

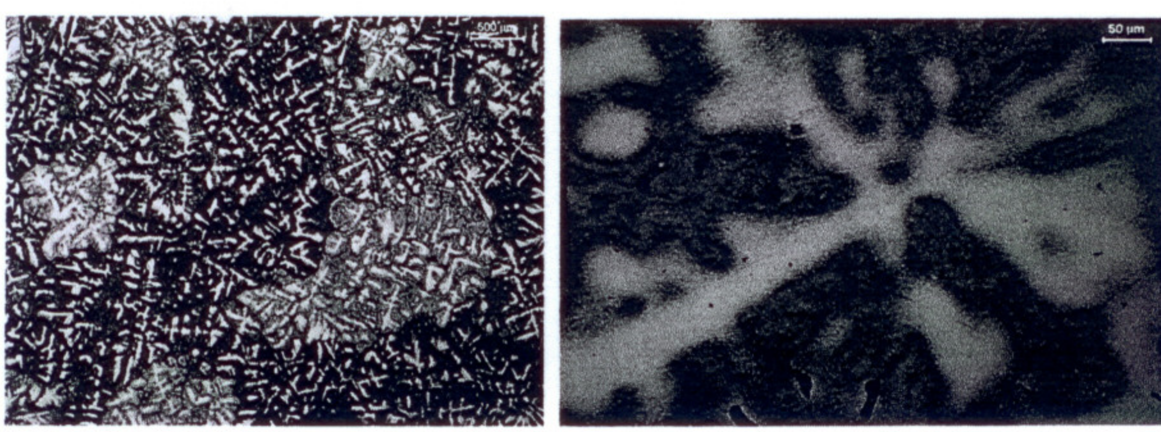


Fig. 2 *Dendritic grains of the sand cast initial, non refined AlZn20 alloy; magnification bars: left –500 μm, right - 50 μm*

The same alloy after addition of the master alloys used in this work shows significantly refined structure – which is presented in Figs 3 and 4.

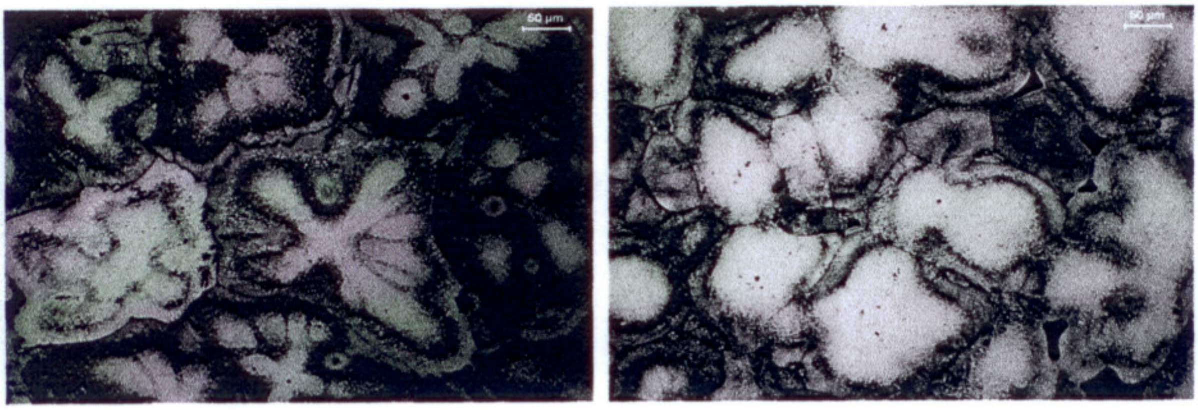


Fig. 3 *Microstructures of the AlZn20 sand cast alloy refined with: left – TiCAl and right – TiBAl master alloys; magnification bars –50 µm*

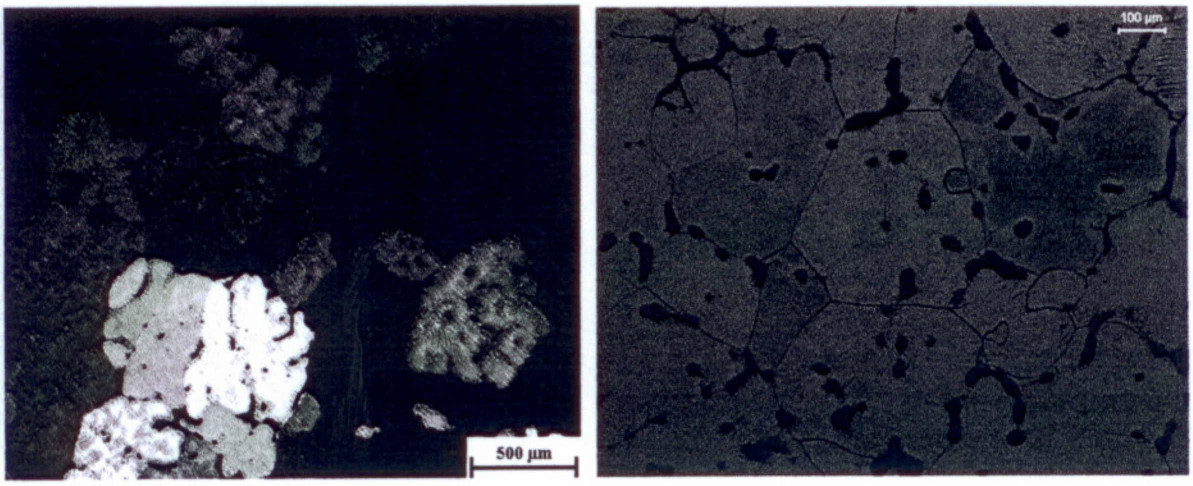
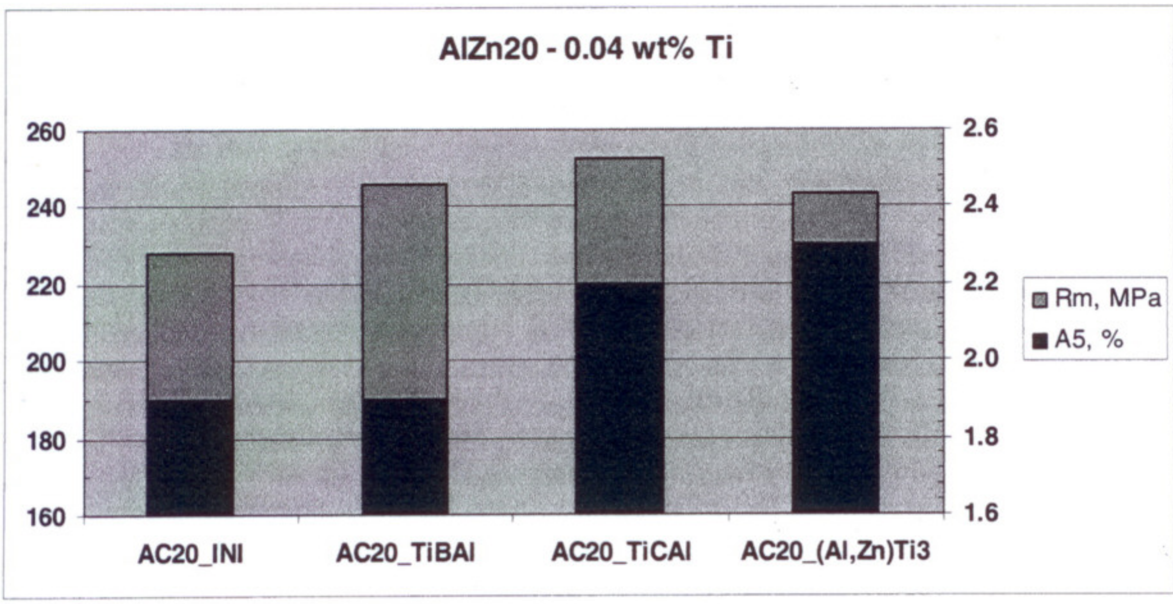


Fig. 4 *Microstructures of the AlZn20 sand cast alloy refined with AlZn-Ti3 master alloy; magnification bars: left –500 µm, right - 100 µm*



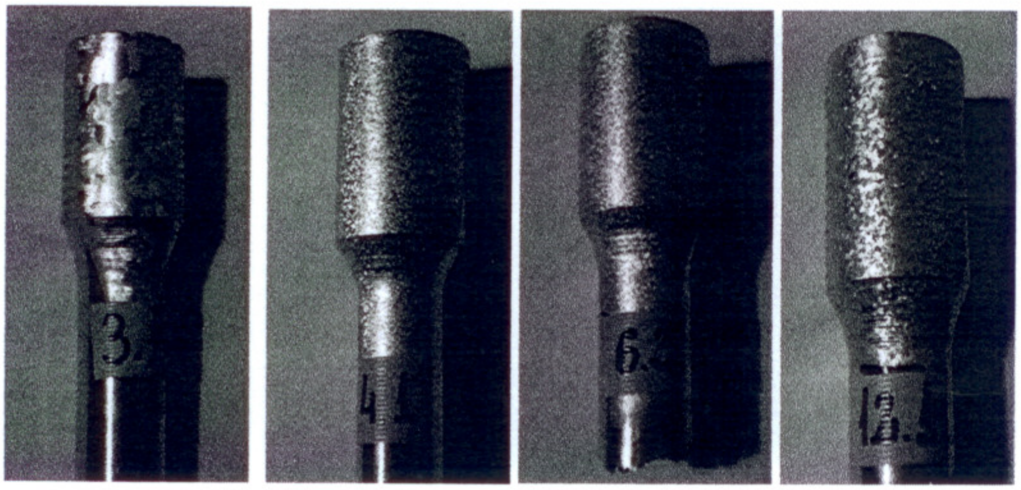


Fig. 5 *Changes of the tensile strength Rm and elongation A5 together with the grain refinement of the examined sand-cast AlZn20 alloy*

FINAL REMARKS

On the basis of the performed examinations the following conclusions can be formulated:

1. All of the used master alloys, i.e. AlTi5B1, AlTi3C0.15 and AlZn-Ti3 show good performance as grain refiners of the examined AlZn20 alloy. The refining effectiveness of the AlZn-Ti3 master alloy is slightly lower than that of the AlTi5B1 and AlTi3C0.15 ones – Figs 3 and 4.
2. The AlZn-Ti3 master alloy has its density very close to the AlZn20 melt and additionally it allows lower processing temperature which avoids detrimental overheating, reduces the costs of energy and material. These features allow improving the mechanical properties of castings by less oxidation and gas pick-up.
3. The refined structure allows improving elongation while tensile strength remains basically preserved – – Fig. 5, which are the advantages of the performed grain-refinement process

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