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Upgrading the alloy AlSi6Cu4 (AK64) cast to the ceramic mould

M. Dudyk [a,*], J. Asłanowicz [b], L.Ościłowski [b]

[a] Department of Manufacturing Technology and Automation, Faculty of Chipless Forming Technology
University of Bielsko-Biała 43 – 300 Bielsko – Biała, Willowa 2

[b] FERRO - TERM Sp. z oo, ul. Przybyszewskiego 176/178, 93-120 Łódź, Polska

*Corresponding author. E-mail address: mdudyk@ath.bielsko.pl

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Abstract

In this article are presented the results of study on the kinetics of the crystallization processes in the refined, modified and filtered Silumin containing copper and the metallographic analysis of the obtained structures. Impact of the upgrading processes – refining, modification and filtration – of the studied alloy AK64 on changes of the impact strength KCV of the cast samples. Original metallographic analysis of the foam filters cast with the studied alloy was carried out. The efficiency of filtration mechanisms on improvement of quality and usefulness of the cast Silumin was demonstrated.

Keywords: Innovative foundry technologies and materials, Crystallization, Aluminum alloys.

1. Introduction

A possibility of fast start up with production of the aluminum alloys makes them most willingly used by contemporary designers in numerous industry fields as suitable material for casting of machine parts.

In the national aluminum alloy foundry most often the metallic charges (pig sows) are used of which castings are made not meeting the requirements of customer.

These castings feature mainly unsatisfactory mechanical and technological properties mainly, among others, impurities.

In the castings manufactured, very frequently, next to incorrectly modified (upgraded) structure the impurities in the form of hard particles are present including mainly aluminum and magnesium oxides (spinals) [1, 2, 3, 6].

Impact of various upgrading processes – refining, modification and filtration – on the morphology of the structure is very significant and therefore it contributes to improvement of mechanical and technological properties of the castings [5].

For the above-mentioned problem the results of structure upgrading by means of refining, modification and filtration of the alloy AlSi6Cu4 (AK64) were presented cast to the ceramic moulds.

2. Methodology of the study and the results

The study presented concerns the impact of refining with the agent ALRAF, modification with the master alloy AlSiSr10 and filtration through the foam filters FERROTERM [7] on the changes in the processes of crystallization and impact strength KCV of the studied silumin. In similar way the ceramic moulds and the tester were cast but after previously putting into them.

The study presented is about the impact of refining with the agent ALRAF, modification with the master alloy AlSiSr10 and filtration through the foam filters FERROTERM [7] on the changes in the processes of crystallization and impact strength KCV of the studied silumin the ceramic filters in order to filter the studied alloys.

On the Fig.1, there are the curves of crystallization, temperature – t = f(τ) and electric conductivity – σ = f(τ) as well as their first derivatives according to the ATD-AED method for the alloys after refining and modification.

The metallographic analysis results for the alloy AK64 re-melted from the pig sows (without using upgrading processes) are shown in the Fig. 2.

They show the internal defects – gaseous porosity and impurities present in the samples of the cast alloy studied.

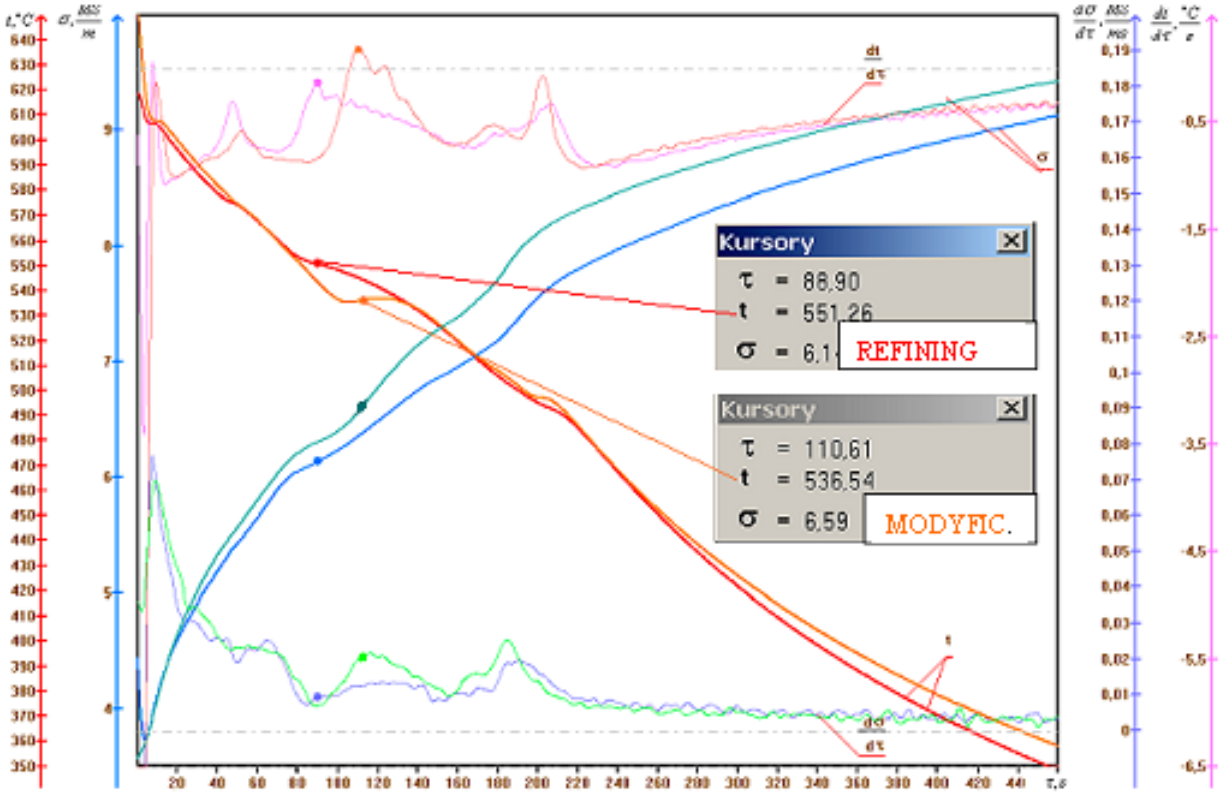
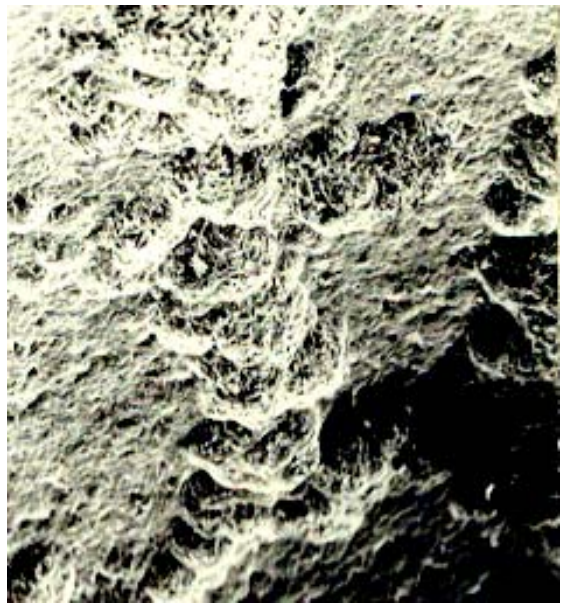


Fig. 1. Crystallization curves for the alloy AK64 cast into the ceramic moulds

a)



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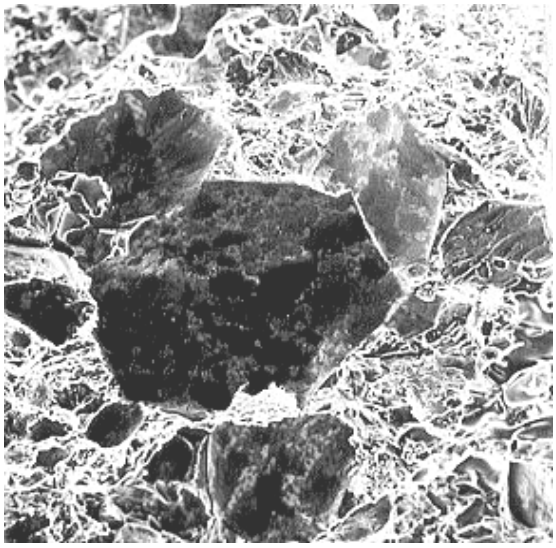

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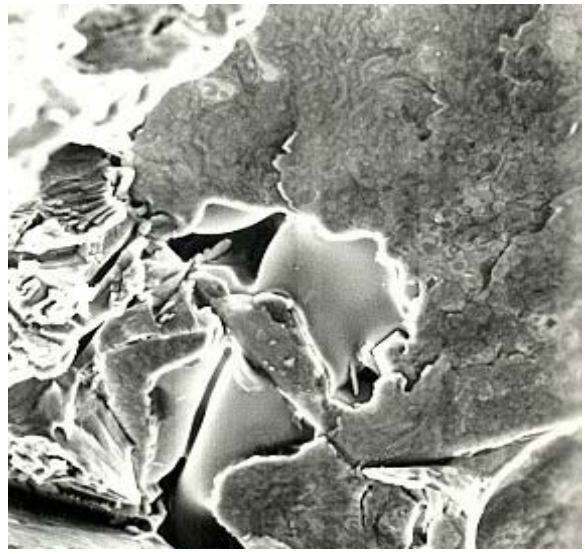

c)

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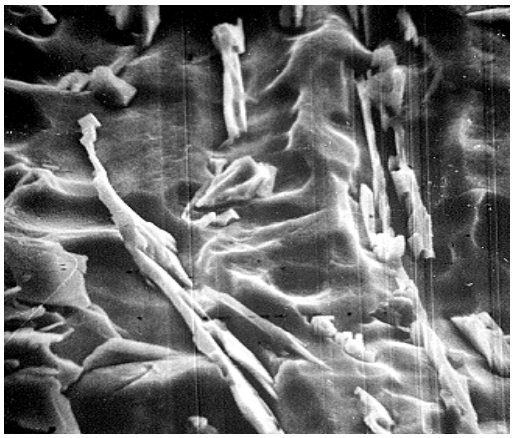
Fig. 2. Defects of microstructure of the alloy AK64 re-melted from the pig sows: a - gaseous porosity, b – oxide films, c – sight of the oxide on the Si crystal

Impact of the applied upgrading processes on the changes in curves of crystallization obtained while making the graphic records from the ATD-AED method confirm the presence of these structures in the form of correct crystallized phases – primary and secondary ones.

The effects of the filtration applied in the study of the alloy AK64 are presented on the microstructures obtained from the polished sections of the castings produced from the alloys studied using the filters.

The results of metallographic analysis after the upgrading processes are shown in the Fig. 3.

a)



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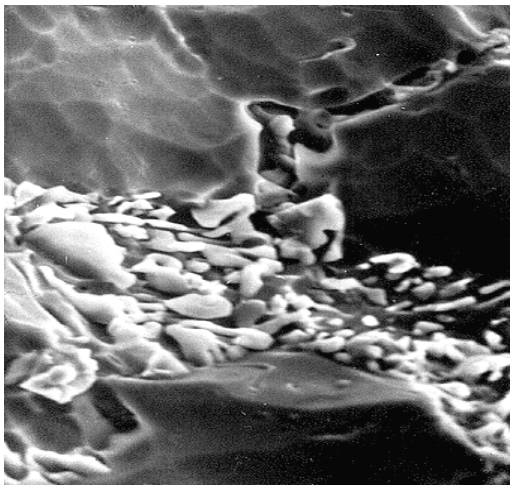

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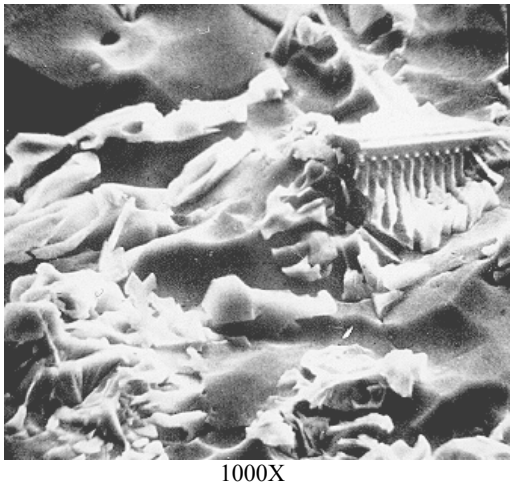
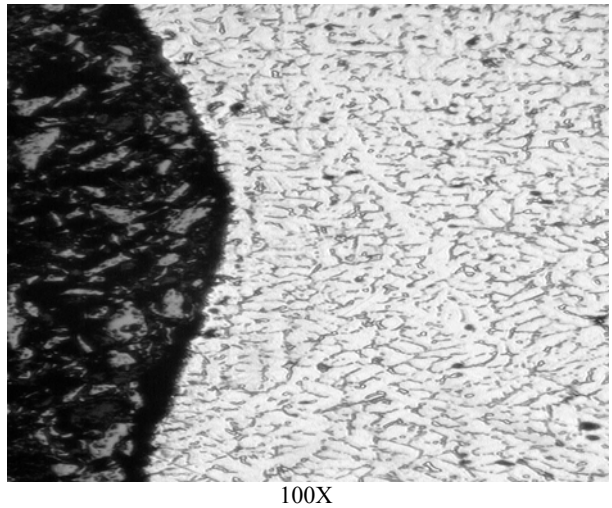


1000X

Fig. 3. Microstructures of the upgraded alloy AK64 cast into the ceramic moulds: a – refined alloy, b – modified alloy, c – view of secondary phases

The effects of the filtration applied in the studied alloy AK64 are shown in the Fig. 4.

They are microstructures obtained from the polished specimens of the castings produced from the alloys studied using the filters.



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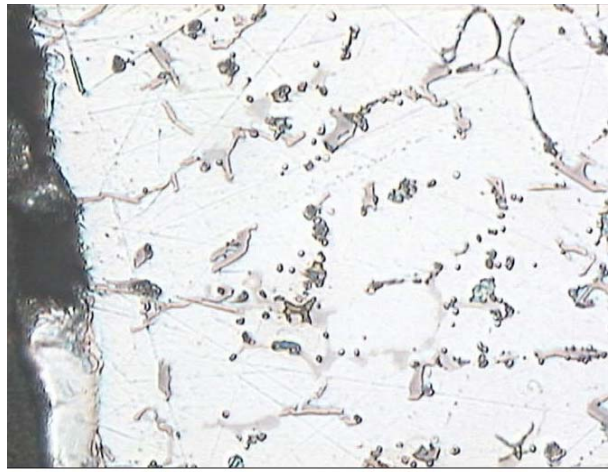
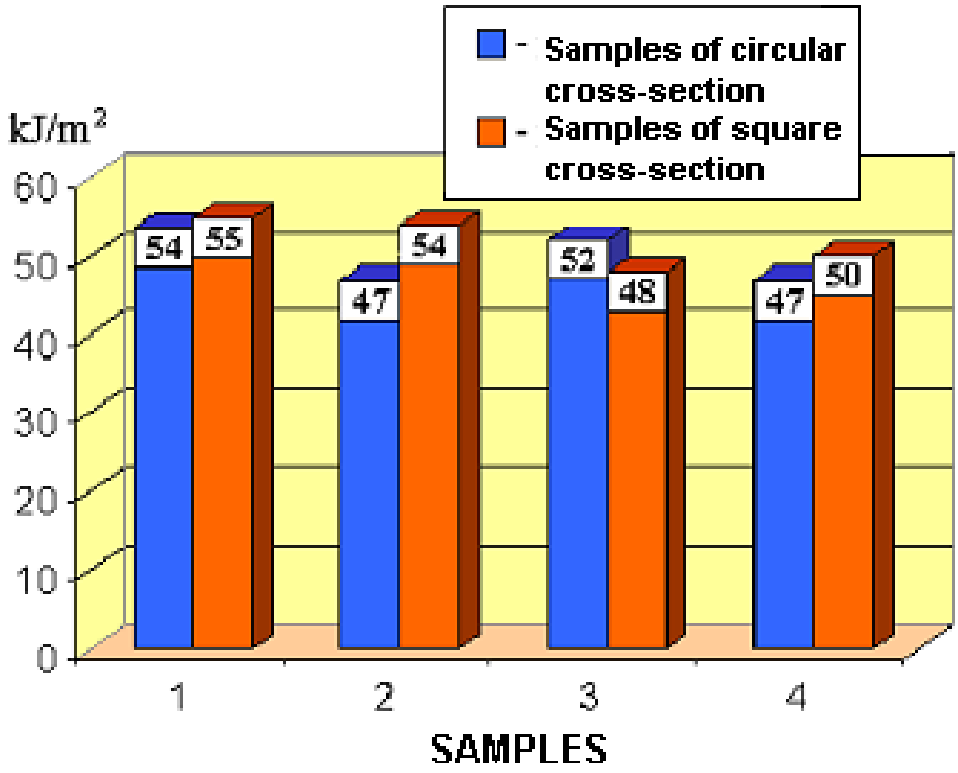


500X

Fig. 4. Shapes and distribution of the retained impurities in the ceramic filter cast with the alloy studied

The applied metallurgic operations and filtration methods were verified using measurements of the impact strength KCV. The results of the impact strength measurement determined on the samples of circular and square cross-sections in the form of the bar diagram are shown in the Fig. 5.

a)



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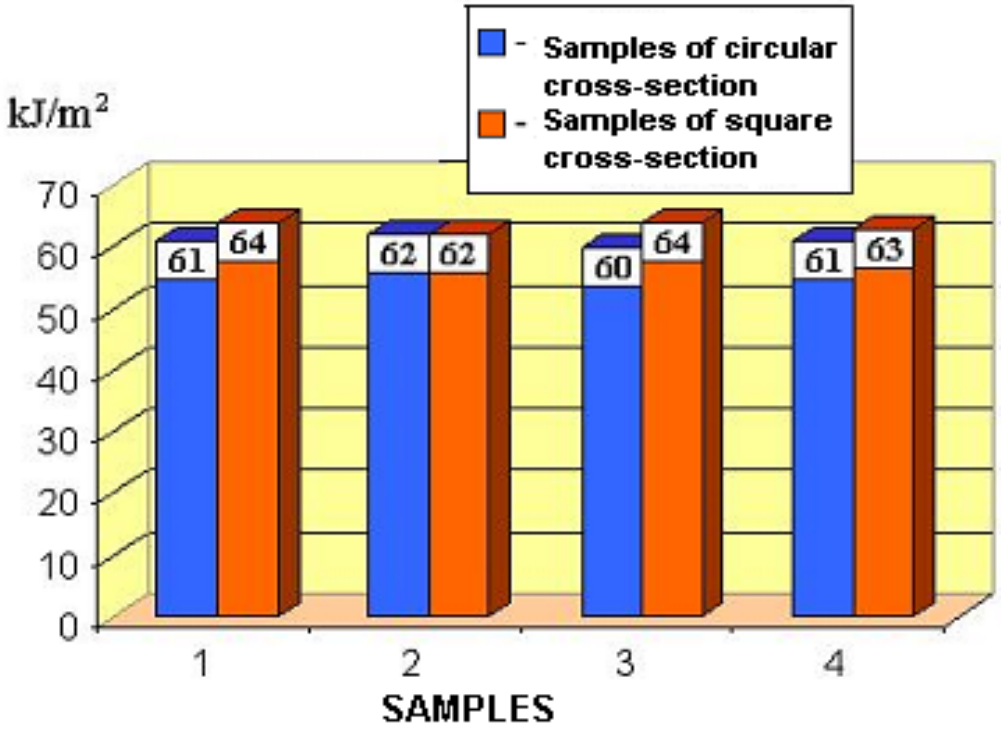

Fig. 5. Comparison of the impact strength KCV of the alloy AK64: a – refined alloy, b – modified and filtered alloy

3. Conclusions

The metallurgical operations used during melting of the alloy confirmed their significant impact on the change in the kinetics of the crystallization process in the silumin studied, cast into the ceramic mould.

Extent and the nature of the obtained changes are visible on the curves recorded during application of the method ATD-AED - Fig. 1.

It was demonstrated that there are relations between thermal and electrical phenomena during solidification and crystallization of the alloys studied. On the recorded crystallization curves – thermal and electrical – there are similar peaks caused by the crystallization of each particular phase making up the structure of the casting.

The metallographic analysis of the alloy AK64 re-melted directly from the pig sows showed occurrence of the internal defects – porosity and oxides – Fig. 2.

For the modified alloy studied, in comparison to the refined alloy, the structure obtained was upgraded to the higher extent. In the interdendritic spaces of the phase α the eutectic α + Si crystallized which predominantly influences the improvement of the mechanical properties.

The microstructures produced from the micro polished specimens on the cast ceramic filters illustrate the form and places of the retained impurities – Fig. 4.

The performed metallurgical operations resulted in purification of the alloy and reduced the temperature of the eutectic crystallization Δt_E of the upgraded alloy.

This, in turn, caused increase in volume fraction of the phase α what in the final effect improved the elastic properties (impact strength) [6] and significantly reduced the dispersion of the results – Fig. 5.

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