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REPUBLIC OF SLOVENIA
MINISTRY OF EDUCATION, SCIENCE AND SPORT

MARTIN
MODELLING OF THERMOMECHANICAL PROCESSING OF THE ALUMINIUM ALLOYS FOR HIGH QUALITY PRODUCTS

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Analysis of chemical composition homogeneity through the cross-section of the rods produced from alloys of 6xxx group

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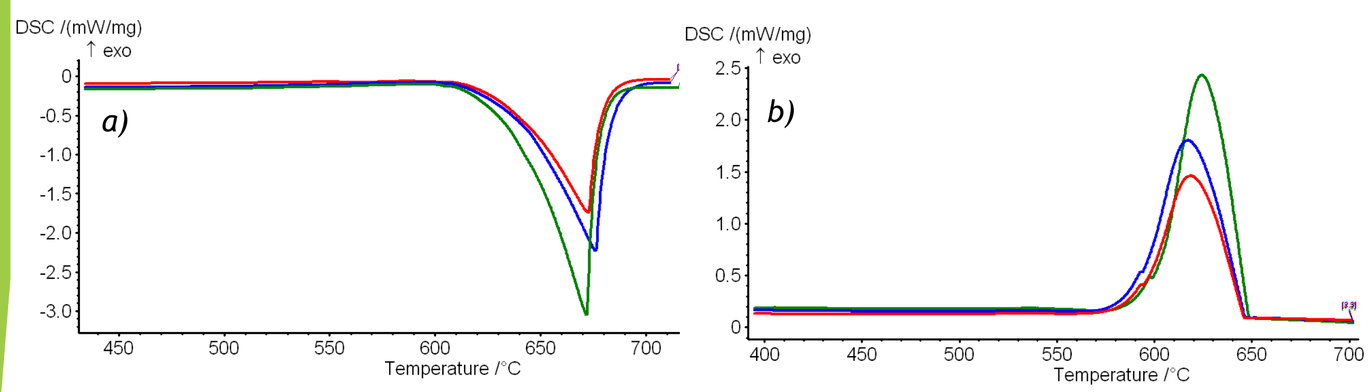
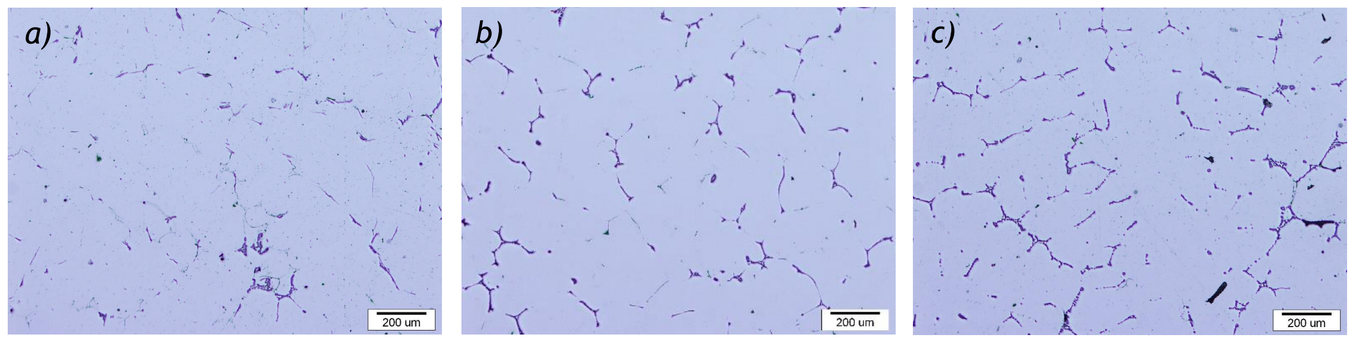
Abstract: The alloys from Al-Mg-Si system provides an excellent combination of mechanical properties, heat treatment at extrusion temperature, good weldability, good corrosion resistance and formability. Due to the high casting speed of rods or slabs the solidification is quite non-equilibrium, resulting in defects in the material, such as crystalline segregations, the formation of low-melting eutectics, the unfavourable shape of intermetallic phases and non-homogeneously distributed alloying elements through the entire cross-section of the rods or slabs. The inhomogeneity of the chemical composition and the solid solution negatively affects the strength, the formability in the warm, corrosion resistance, and can lead to the formation of undesired phases due to segregation in the material.

In this experimental investigation, the cross-section of the rod from two different alloys of the 6xxx group were investigated. From the cross-section of the rod, samples for differential scanning calorimetry (DSC) at three different positions (edge, D/4 and centre) were taken in order to determine the influence of inhomogeneity on the course of DSC curve. Metallographic sample preparation was used for microstructure analysis, whereas the actual chemical composition was analysed using a scanning electron microscope (SEM) and an energy dispersion spectrometer (EDS).

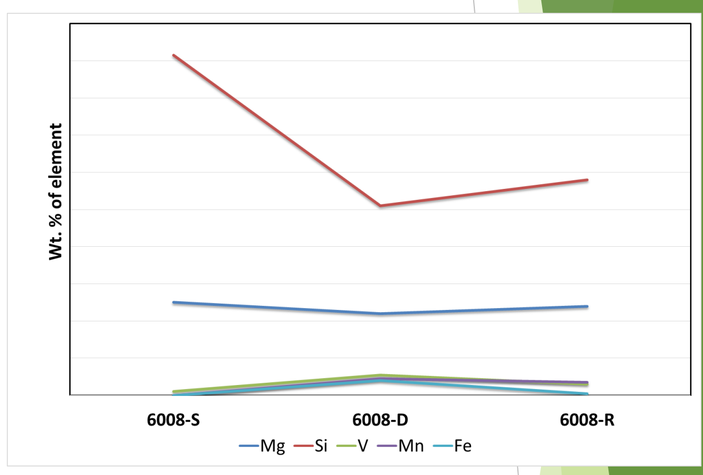


Comparison of heating (a) and cooling (b) DSC curves of EN AW 6008 alloy from different places of the rod: blue - centre, green - D/4, red - edge.

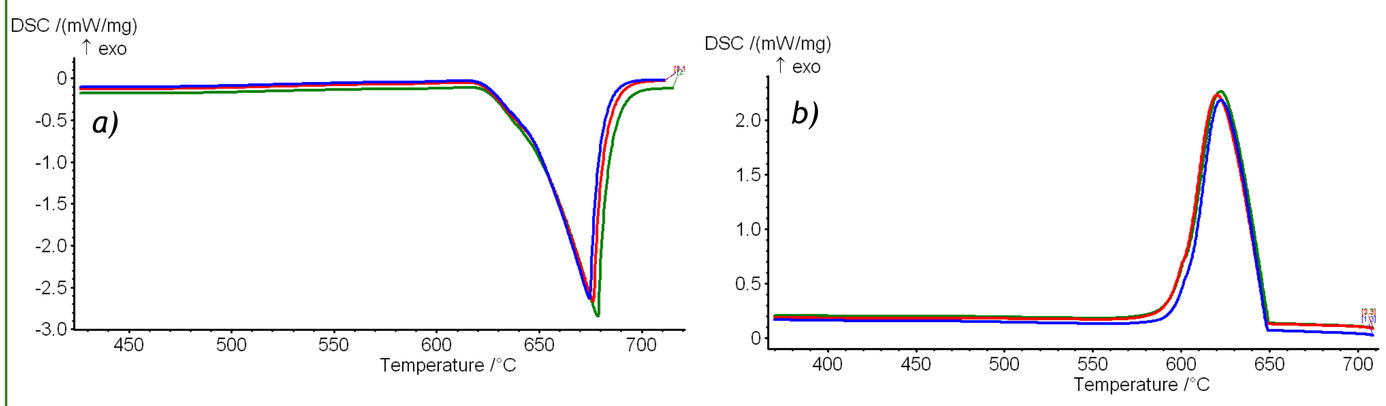


Microstructures of 6008_centre sample (a), 6008_D/4 sample (b) and 6008_edge sample (c).

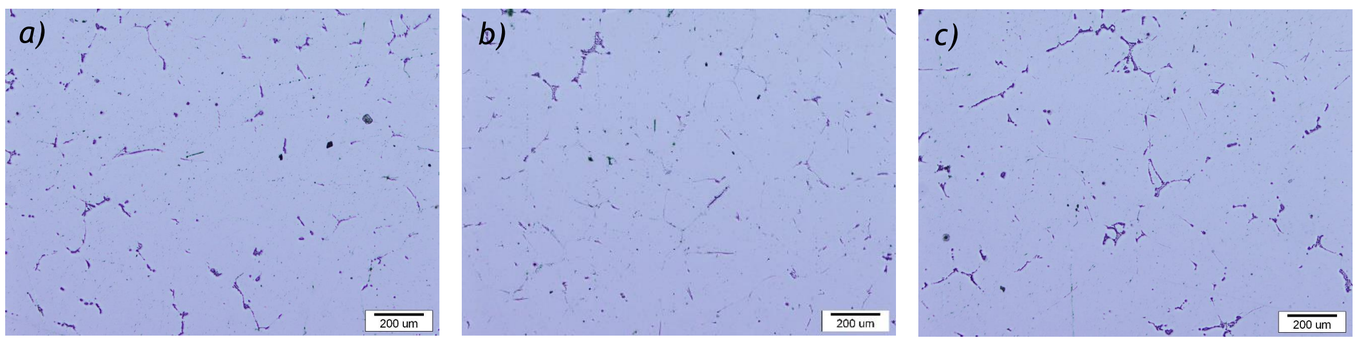
Results of the EDS analysis on the samples after the DSC experiments confirm the preliminary conclusions, whereas only the fluctuation of certain chemical elements is presented. It can be seen that the chemical composition is not homogeneous through the cross section of the as cast rod. The largest deviations in the EN AW 6008 alloy are found in a silicon concentration, which varies by more than 0.5 wt.%. Minor deviations are also found in concentrations of magnesium, vanadium, manganese and iron, which can be eliminated by appropriate homogenization annealing.



EDS analysis of samples after DSC analysis from the alloy EN AW 6008 taken from the cross-section of the rod at D/4, the centre and the edge.

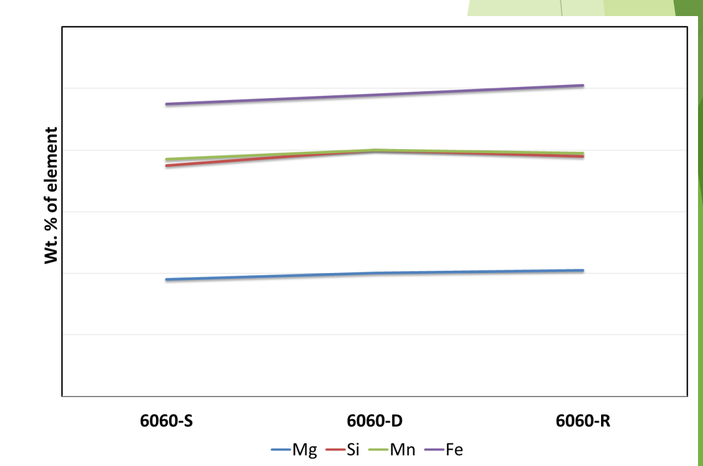


Comparison of heating (a) and cooling (b) DSC curves of EN AW 6060 alloy from different places of the rod: blue - centre, green - D/4, red - edge.



Microstructures of 6060_centre sample (a), 6060_D/4 sample (b) and 6060_edge sample (c).

Minor fluctuations in the chemical composition are shown by EDS analysis of the alloy EN AW 6060, which was assumed already after the DSC analysis, where the DSC curves are very similar. The concentrations of magnesium, silicon, manganese and iron are slightly increased from the centre to the edge. EN AW 6060 alloy rods are already fairly homogeneous in chemical composition in as cast state.



EDS analysis of samples after DSC analysis from the alloy EN AW 6060 taken from the cross-section of the rod at D/4, the centre and the edge.

CONCLUSIONS

The aim of this investigation was analysis of chemical composition homogeneity through the cross-section of the rods produced from alloys of 6xxx group. DSC analysis indicated non-homogeneity of the experimental alloys.

From the results of the analysis of the cross-section of the rod from the EN AW 6008 alloy, it is evident that the chemical composition is not homogeneous through the cross-section of the as cast rod. The greatest deviations are observed in the concentration of silicon, which also fluctuates by more than 0.5 wt.%. Minor deviations are also found in concentrations of magnesium, vanadium, manganese and iron, which can be eliminated by appropriate homogenization annealing.

Based on the results presented above, it can be concluded that the alloy EN AW 6060 is already quite homogeneous in the as cast state through the cross-section of the rod. The concentration of some elements slightly increases from the centre to the edge.