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MICROSTRUCTURE CHARACTERIZATION OF ALSI7MG0.3 GAS TREATED ALLOY

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Abstract: *The densities and densities index (DI) for samples solidified both in air and in vacuum (80 mbar) with a VAC-TEST SYSTEM apparatus having a DENSITY TERMINAL device. To establish the mechanism of porosity formation and to evaluate the gaseous porosity, respectively the shrinkage porosity, was used the quantitative microstructure and macrostructure analysis: metallographic microscope BX6M, video camera KPM1 and BUEHLER OMNIMET EXPRESS with a program in 4.0 version .*
Key words: *micro porosity, gas, vacuum, density index, refining*

1. INTRODUCTION

Hypoeutectic cast Al-Si alloys are highly susceptible to occurrence of the sharp edges of the coarse acicular silicon phase that promote crack initiation, and propagation in alloys and also the porosity formation

Porosity in aluminum alloys occurs in one of three ways: hydrogen emerging from the liquid solution, shrinkage during solidification or, as is usually the case, by combination of these effects (Moldovan, 2001; Moldova net. Al., 2003).

It is generally accepted that micro porosity forms easily when the following conditions are satisfied (Lu et al., 2004; Zhu et al., 2006, Lashkari et al., 2009):

- poor mass feeding;
- difficulties in interdendritic feeding;
- low pore nucleation energy;
- low pressure, i.e., either atmospheric pressure or pressure due to surface tension;
- high hydrogen pressure, i.e., high gas content and low gas solubility in the solid.

Porosity formation is controlled by hydrogen concentration, inclusion content, modification, grain refining, freezing range and solidification rate.

These effects are developing simultaneously, interacting to realize the observed porosity and making it difficult to state with factor is predominant in causing the porosity.

The purpose of this study was to determine the mechanism of porosity formation in AlSi7Mg0.3 alloy treated with gas and the influence on different factors on the porosity.

2. EXPERIMENTAL PROCEDURE

The alloy used for the porosity studies was AlSi7Mg0.3. Its chemical composition is presented in table 1.

AlSi7Mg0.3 alloy was melt in an electric furnace with Kanthal resistance, with capacity of 2 kg. The temperature was measured with a chromel/alumel thermocouple. The first samples were extracted from the metallic bath before the treatment with gas, and the next series (2, 3, 4 and 5) were extract after degassing 5, 10, 15 and 20 minutes.

Al	Si	Fe	Cu	Mn	Mg	Zn	Cr	Pb
balance	7.05	0.14	0.016	0.06	0.34	0.021	0.001	0.002

Tab. 1. Chemical composition (wt. %) of AlSi7Mg0.3 alloy

The samples were solidified in metallic crucibles, coated with a ceramic layer, both at 1 atmosphere and in vacuum with a remanent pressure of 80 mbar. Using a VAC-TEST SYSTEM device equipped with a DENSITY TERMINAL were determined the densities and density indexes for AlSi7Mg0.3 alloy.

The density index was calculated with the relation:

$$DI = \frac{\rho_{air} - \rho_{vacuum}}{\rho_{air}} \qquad (1)$$

where: ρ_{air} is the density of the alloy determined at solidification in air; ρ_{vacuum} is the density of the alloy determined at the solidification in vacuum.

3. EXPERIMENTAL RESULTS AND INTERPRETATION

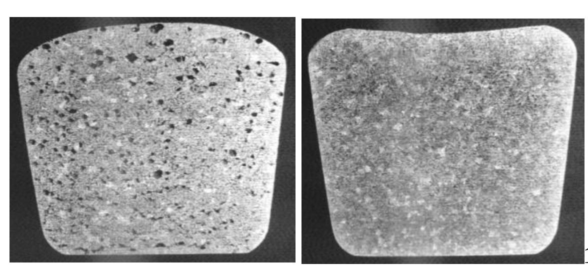
From the experiments were obtained, according to the used gas, different values of the density indexes (table 2).

Sample	Density, g/cm^3		Density Index, DI	Time degassing, min
	in air	in vacuum		
1	2.680	2.402	10.4	0
2	2.636	2.383	9.6	5
3	2.895	2.632	9.1	10
4	2.630	2.560	2.7	15
5	2.634	2.303	0.8	20

Tab. 2. Density and the density indexes of alloy

In figure 1 are presented the macro-structures of the samples. It is observed a gaseous porosity decrease at the increasing of time degassing, on the variation curve of the density index (DI) presented in figure 2.

In samples 1, 2, 3 and 4 we can remark contraction and gaseous micro-porosities. The gaseous micro-porosities decrease at increasing time degassing. In samples 1, 2 and 3 is also observed areas of contraction porosity. Porosity decrease of the alloy AlSi7Mg0.3 alloy samples is noted after 15 minutes of bubbling with inert gas (Ar).



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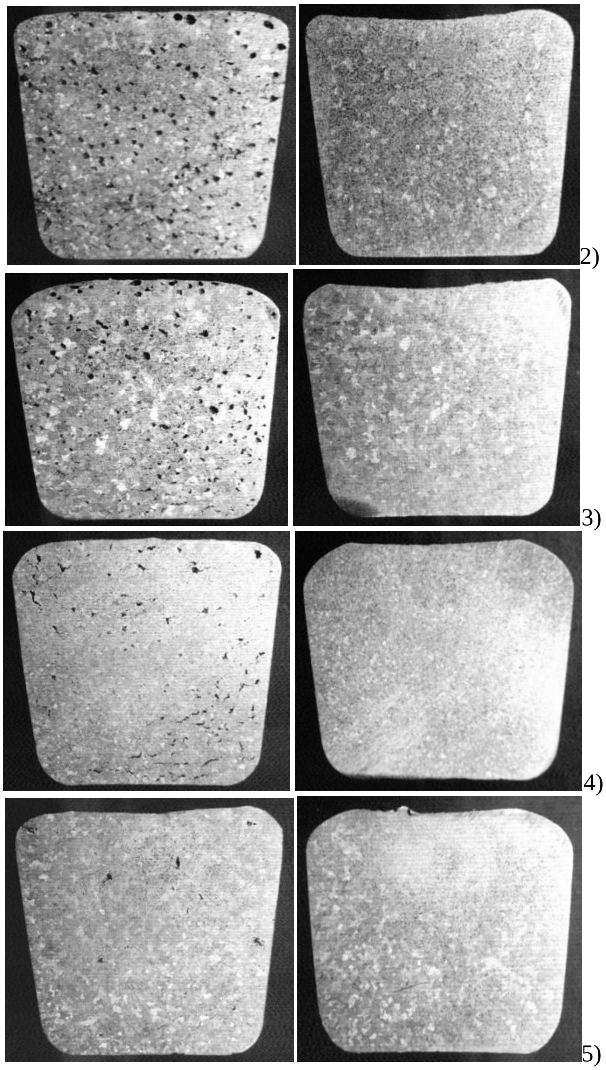

Fig. 1. Macrostructure of the samples 1, 2, 3, 4 and 5, solidified in vacuum (left) and solidified in air (right)

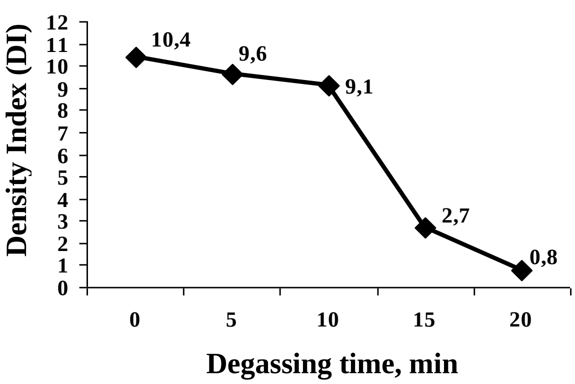

Fig. 2. The density index variation versus the degassing time in AlSi7Mg0.3 alloy

By electron microscopy were made measurements in the immediate proximity of pores from AlSi7Mg0.3 alloy, for determine their phases and their composition in the solidified samples, to correlate them with the nature of porosity and the mechanism of the pores formation.

In figure 3 are presented the images of composition and contents variation of Si (a) and Mg (b) for AlSi7Mg0.3 alloy near a pore.

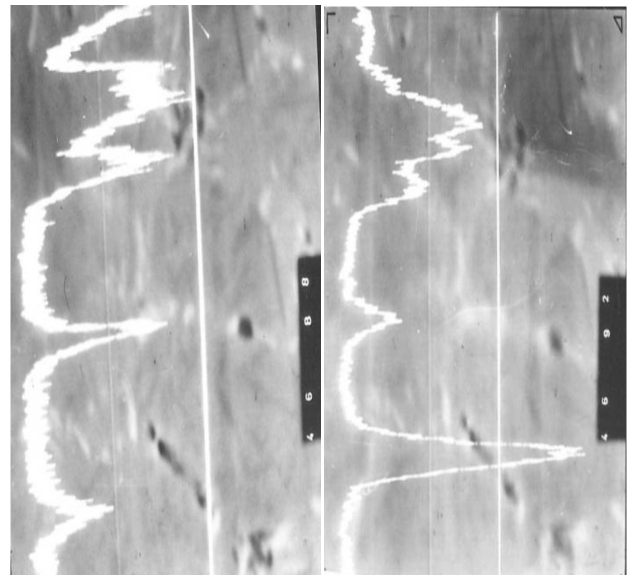

Fig. 3. Images of composition and contents variation of Si (a) and Mg (b) for AlSi7Mg0.3 alloy near a pore.

Analysis by electron microscopy indicates the formation of Mg2Si compound being under conformity with ternary equilibrium diagram Al-Si-Mg, which leads to micro-porosity in adjacent areas of the compound.

4. CONCLUSIONS

The degassing time increase of AlSi7Mg0.3 alloy leads to the strong decrease of the density index (DI), respectively of the total porosity.

The 5 min and 10 min degassed samples, with high values of the density indexes (9.6 and 9.1), like non-degassed samples (10.4), shown especially gas porosity while the 15 min and 20 min degassed samples with low values of the density indexes (2.7 and 0.8) had mostly shrinkage microporosities and non-metallic inclusions.

5. REFERENCES

Moldovan, P. (2001). *Treatment of Molten Metals,* V.I.S. PRINT, Bucharest, Romania

Moldovan, P.; Popescu, G.; Dobra, Gh. & Stănică, C. (2003). Microstructure evaluation and microporosity formation in AlSi7Mg0.3 alloys, *Light Metals*, pp. 937 – 944

Lu, L.; Nogita, K.; McDonald, S.D. & Dahle, A.K. (2004). Eutectic Solidification and Its Role in Casting Porosity Formation, JOM, volume 56, issue 11, pp. 52-58

Zhu, J.D.; Cockcroft, S.L. & Maijer, D.M. (2006). Modeling of Microporosity Formation in A356 Aluminum Alloy Casting, Metallurgical and Materials Transactions, volume 37A, pp. 1075-1078

Lashkari, O.; Yao, L.; Cockcroft, S. & Maijer, D. (2009). X-Ray Microtomographic Characterization of Porosity in Aluminum Alloy A356, Metallurgical and Materials Transactions, volume 40A, pp. 991-995