THE CRYSTAL SEGREGATION DURING CASTING OF THE ALLOY $AlCu_4MgMn$

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Abstract: *A target of this experiment is to study the influence of two moulds (metal and bentonic) on the size of dendritic cells and their crystal inhomogenity under the terms of individual dendrites themselves by typical gravitational casting of the alloy AlCu4MgMn. Intentionally was chosen the alloy with more alloyed elements, where is also a hypothesis of bigger crystal inhomogeneity, which can we uncover with the help of colour corroding of quantitative evaluation of the size of dendritic cells of both mould types.*
Keywords: *Crystal segregation, metal mould, bentonic shaping mixture, colour metallography, EDS analysis.*

1. Introduction

The alloys of Al-Cu-Mg, chiefly duralumins AlCu4Mg, AlCu4Mg and AlCu4MgMn, reaching significant compactness after hardening by heat processing (R_m až 530 MPa). Maximal solubility of copper in stiff solution of aluminium is under steady conditions 5.7 hm.%Cu by temperature of eutectic reaction 548.2 ºC. The alloys of AlCuMg reach significant compactness after hardening; natural senescence is their advantage. Next alloyed element in industrial alloys of Al-Cu-Mg is Mn, which raises the compactness. In the alloy AlCu4Mg occur primarily a binary eutectic $\alpha + CuAl_2$ and small amount of ternary eutectics $\alpha + CuAl_2 + Cu_2Mg_2Al_5$, further Mg_2Si, $FeAl_3$, AlFeMnSi, AlCuFeMn etc. [1, 6].

The disadvantage if these alloys are low resistance against rust and proneness to significant crystal and zone segregation. Cause of establishment of crystal segregation is the selective hardening of crystal by gradual change of stiff phase composition. Important parameters influencing establishment and stage of crystal segregation are chemical composition of alloy, diffusion in solid and liquid phase, influence of cooling castings´ speed, to put it differently heat drain out of castings rate and that depends on chosen mould. Crystal segregation significantly influences mechanical and corrosive qualities of the alloy. Crystal segregation can be suppressed by homogeneous annealing, which will be subject of next experiment [1].

1.1 Casting of Al alloys and their forms

The ways of casting and right choice of mould has fundamental meaning on final structure and qualities of alloys. In majority industrial branches are to date used forms made of tool steel by classical or electro erosion machining. All metal forms are made on flake way on machine tool of steel solid or by stowing of steel parts to make a metal form. Material of metal forms must put up with quite high temperatures, in some cases about 400 to 600°C [5].

The most frequent material of forms for very exposing places is steel "CSN 42 0002", alloyed elements Cr – V – Mo and it is meant for work by high temperatures. Big disadvantage by their production is mainly their high price and laboriousness. From this reason is profitable to product forms by cheaper technologies on basis of sand. Bentonic sands allow casting of big forms raw, because they are binding and well-permeable. In contrast to pouring into metal forms, they are cheaper, but castings from metal forms are characterized in that excellent internal compactness, higher smoothness of surface, good dimensioned values and mechanical qualities of castings [3,4].

2. Procedure of experimental casting

For preparation of alloy castings was used crude material supplied directly by producer, which was prepared in percentage proportion of chemical composition wickedly rule CSN 42 4250. Smelting given material realized in furnace by temperature 700°C, furnace temperature was scanned by digital thermometer with accuracy on ± 2°C. Parameters of prepared castings were 40 / 50 x 100 mm. The first casting was prepared by gravitational casting into metal form, which was treated with protective coat and preheated for working temperature about 220°C. The second casting was prepared under the same conditions and by the same chemical composition like the first casting. The casting was gravitational straight into bentonic form, which had room temperature.

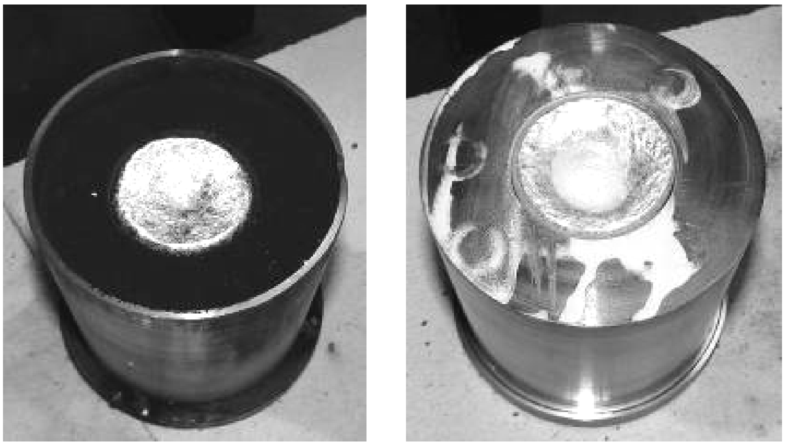

Fig.1. Bentonic and metal forms

Structure of prepared castings was evaluated by using metallographic methods into macrostructure and microstructure. Macrostructure was evaluated after mechanical grinding, polishing and corroding by NaOH by higher temperature. Microstructure of prepared castings was monitored in central area in corroding state by solution of orthophosphoric acid [2].

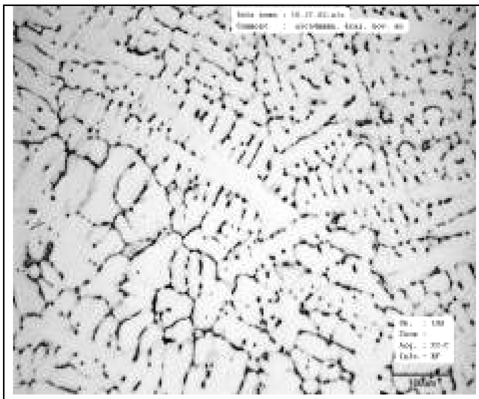

Fig.2. Microstructure AlCu4MgMn - metal form, x 100

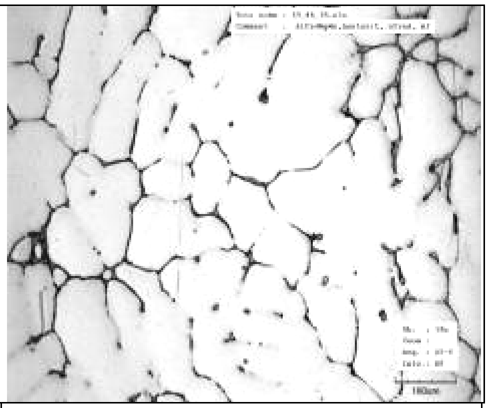

Fig.3.Microstructure AlCu4MgMn - bentonic form, x 100

For colour identification were prepared metallographic sections from castings that were mechanical grinded, polished and colour corroding. Colour corroding was made by solution of potassium permanganate in alkaline surroundings of sodium hydroxide. Exemplars, prepared in this way, were watched by confocal laser optic microscope. This method enabled us, among others, to observe and document participating intermetallic phases and heterogeneity of chemical composition under the terms of dendritic cells on high-quality level. Individual colour shades after cell´s cross-section prove inhomogeneity of chemical composition [2,5].

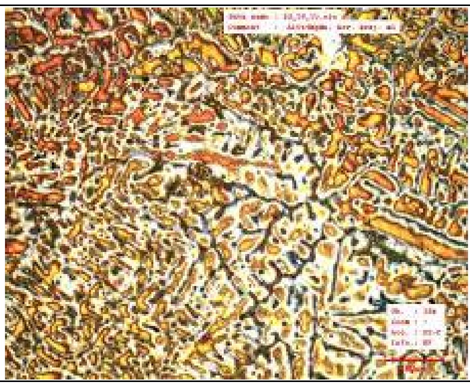	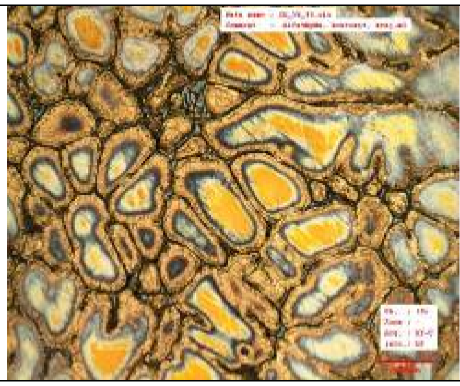
Fig.4. Microstructure AlCu4MgMn - metal form, x 100	*Fig.5. Microstructure AlCu4MgMn - bentonic form, x100*

Chemical composition of basic structural components was realized on scanning electron microscope with help of EDS analysis. EDS is very suitable method for identification of all present elements, foreign particle and individual structural components in alloys. With the help of this method was determined chemical composition of eutectic and internal area of dendrite (Fig.5).

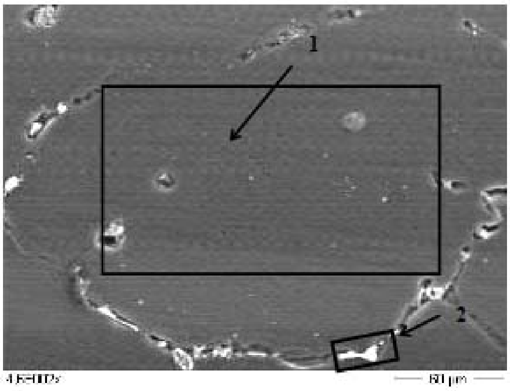

Fig.6. EDS analysis eutectic and internal area of dendrite

Tab.1.

EDS analysis

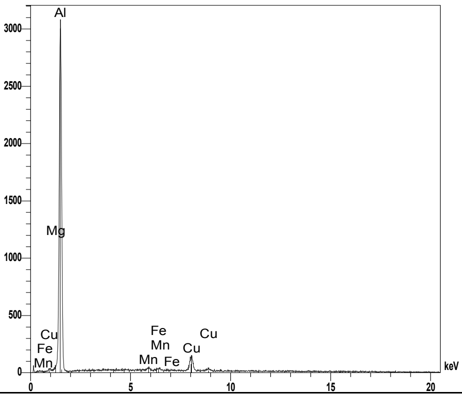

Fig.7. EDS analysis internal area of dendrite

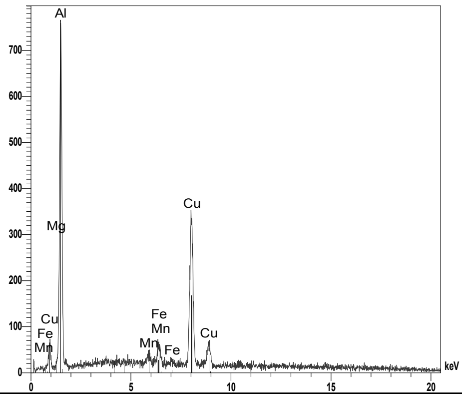

Fig.8. EDS analysis eutectic

	1 [weight %]		2 [weight %]
Mg	1.53	**Mg**	1.16
Al	89.19	**Al**	64.46
Mn	0.58	**Mn**	0.59
Fe	0.51	**Fe**	1.83
Cu	8.19	**Cu**	31.97

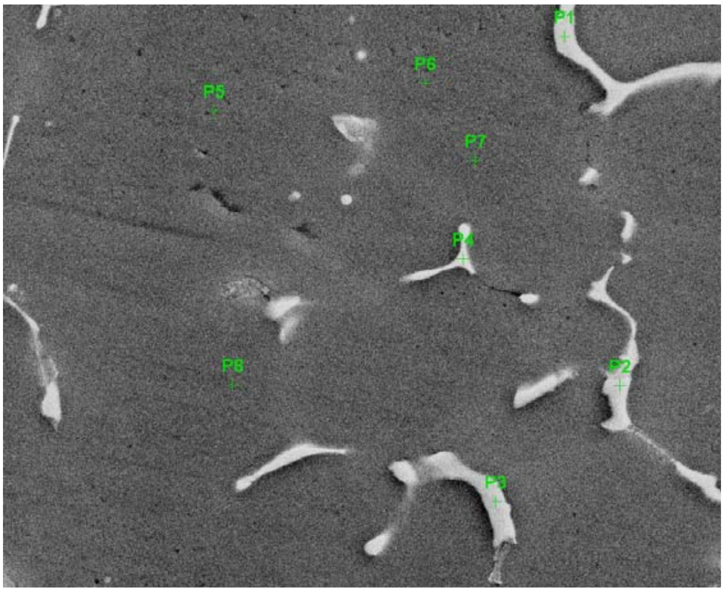

Fig. 9: The dendritic cell alloy AlCuMgMn - pattern EDS analysis

Tab. 2

Pattern EDX analysis values of AlCu4MgMn alloy's marked places Fig.9 P1-P8

	P1	P2	P3	P4	P5	P6	P7	P8
Cu [%]	18,61	27,00	11,60	22,80	1,12	1,14	1,57	3,31
Mn [%]	0,06	0,03	0,10	0,10	0,09	0,13	0,10	0,13
Mg [%]	2,25	1,72	1,74	1,55	2,33	1,79	2,85	3,79
Al [%]	79,08	71,25	86,56	75,56	96,47	96,94	95,48	92,77

3. Conclusion

From executed experiment, evaluation of macrostructures, EDS analysis results and quantitative evaluation of dendritic cell, it is possible to state following:

1. From point of executed macrostructures of differently prepared alloys is obvious, that size of dendrites by alloys casting into bentonic shaping mixture is bigger than by alloys casting into metal form.
2. By numerical evaluation of average size of dendritic cells was determined average (20 measures) size of cells. Average size of dendritic cells by alloys casting into metal form was 163 μm. By alloys casting into bentonic shaping mixture was determined average 356 μm. It follows, that size of dendritic cells is by alloys casting into bentonic form 2, 2 times bigger, than by alloys casting into metal forms. From results can be univocally states, that by casting into metal form it can be reached qualitatively the structure of pouring grain in contrast to casting into bentonic shaping mixture.

3. From EDS analysis of dendritic reticulation is clear, that it is mainly about binary eutectic $CuAl_2$ or ternary eutectic $\alpha + CuAl_2 + Cu_2Mg_2Al_5$. Except of above mentioned eutectics, cells reticulation is also formed by phases $CuAl_2$, AlFeMnSi, AlCuFeMn, etc.

References: **1.** Michna,Š., Lukáč I.,Louda et al., *Aluminium materials and technologies from A to Z*, ISBN 978-80-8244-18-8, Printed by Adin, s.r.o.,Prešov 2007. **2.** Lukáč I., Michna,Š., *Atlas struktur a vad u hliníku a jeho slitin*, Deltaprint, Děčín 1999, ISBN 80-238-4611-6. **3.** Michna,Š., Lukáč I., *Technologie a zpracování kovových materiálů*, Adin, s.r.o.,Prešov 2008, ISBN 978-80-89244-38-6.

РАЗРАБОТКА И ПРАКТИЧЕСКОЕ ОСВОЕНИЕ ИННОВАЦИОННЫХ ТЕХНОЛОГИЙ В ИНЖЕНЕРНОМ ОБРАЗОВАНИИ

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Actuality of the practical mastering of innovative technologies is grounded by development and introduction to teaching practice of computer presentations as an optimum form of lead through of employments on Ukrainian.

Роль образования в современном обществе поистине уникальна. В условиях политического и идеологического конформизма, экономического кризиса и, как следствие - пересмотра социальных представлений и стереотипов, именно образование становится тем единственным социальным институтом, через который осуществляется трансляция и воплощение национальных базовых ценностей и поддерживается процесс воспроизводства социального опыта. Более того, смена ориентиров в образовании позволила переосмыслить как роль, так и цели образования как такового. Так, до последнего времени образование было ориентировано на формирование знаний и навыков, достаточных лишь для приспосабливания личности к общественным обстоятельствам. В настоящее время образование все более ориентируется «на создание таких технологий и способов влияния на личность, в которых обеспечивается баланс между социальными и индивидуальными потребностями и которые, запуская механизм саморазвития (самосовершенствования, самообразования), обеспечивают готовность личности к реализации собственной индивидуальности и изменениям общества» [1].

Необходимость создания указанных технологий обусловила большую часть инновационных процессов, начало которым было положено в 80-х годах XX века. Именно в это время проблема инноваций и, соответственно, её понятийное обеспечение стали предметом специальных научных исследований. Термины «инновации в образовании» и «педагогические инновации», употребляемые как синонимы, были научно обоснованы и введены в категориальный аппарат, как педагогики, так и образования в целом, определяя инновацию как «нововведение в педагогическую деятельность, изменения в содержании и технологии обучения и воспитания, имеющие целью повышение их эффективности» [6].

И хотя «в современном образовании (и для научной, и для педагогической общественности) не существует сколь-нибудь определенной и общепринятой Концепции инновационной деятельности», одним из ведущих направлений в данной области представляется осуществление исследований, направленных не столько на разработку теоретической составляющей инновационной деятельности, сколько на практическое освоение и анализ использования новых технологий, поскольку «педагогические инновации явным образом обнаруживают себя лишь в самой образовательной практике, в тех последствиях, которые они порождают при своей реализации» [7].