INCORPORATION AND DISPERSION OF THE REINFORCED PARTICLES IN A MATRIX OF AN ALLOY WITH ALUMINIUM BASES

CHIHAI S., ROMAN C., HUȚANU M., MIHĂILESCU N., ALEXANDRU A.

,Technical University "Gh.Asach" Iasi

Abstract: To obtain a metallic matrix composites with a uniform incorporation and dispersion of particles require the control of technological parameters. The fabrication of MMCs by means of casting methods is necessary to prepare a liquid metallic matrix/non-metallic particles suspensions before casting. The Vortex method is one such method to prepare suspensions. In this case the feeding rate of liquid matrix with particles is a important technological parameters which influences the uniformity of incorporation and dispersion of particles within metallic matrix. The present paper shown experimental researchs concerning of the influence of feeding rate on the incorporation degree and dispersion particles in an aluminium matrix composites.

Keywords: metalic matrix composite, Vortex method, complementary phase, feeding rate.

1.INTRODUCTION

At present, the metallic matrix composites (MMCs) are a distinct category of materials which have different properties by comparison with the usual materials. The essential advantage of MMCs consists in possibility of the achievement of materials with new and requied properties.

In speciality literature the Vortex method is considered the most efficient method to prepare the liquid alloy/non-metallic particles suspensions. However, it was made evident experimentally that the composite materials, which were obtained by casting of the suspension prepared by previous method, included the particles agglomerations with great sizes than particles sizes. Also, during preparation of suspensions, the non-metallic particles were separated from these because of sedimentation or flotation. These phenomena were owed the different densities between liquid metallic matrix and non-metallic particles.

The incorporation and dispersion of non/metallic particles in metallic matrix are depended on the following parameters: chemical composition of metallic matrix, particles type, pre-heating temperature of particles, feeding rate of liquid matrix with particles, rotation speed of stirrer, the shape of stirrer palette etc.

2. EXPERIMENTAL TECHNIQUE

The liquid aluminium matrix/non-metallic particles suspensions were prepared by Vortex method. In the case of this method, the non-metallic particles are introduced and scattered into the liquid aluminium alloy by means of a stirrer witH palette.

The plant used for the preparation of suspensions is made up of a maintenance chamber at different temperatures, a stirring device, a measuring and preheating unit particles and a vibration device *I/I.* The superheating and heating of metallic matrix take place inside a melting furnace with electric rezistors. Then the metallic melt is introduced into crucible placed in the maintenance chamber. In this crucible takes place the preparation of suspension. To prevent the compactation and sloping of the particles flow it was used a vibration device coupled with the pre-heating and measuring device, which during particles flow worked permanently.

The liquid matrix/non-metallic particles suspensions were casted into metallic molds, so that, the solidification rates of suspensions were very high, stoping the sedimentation or flotation of particles from within metallic matrix /1,2/.

The composites obtained experimental were made up from ATSil2CuNiMg and ATCu4MgTi aluminium alloys matrix (Table 1) and the graphite or SiC particles as complementary phases (Table 2).

The chemical compositions of aluminium alloys. Table 1

No.	Alloy	Chemical composition, % weight							
		Cu	Fe	Si	Mn	Mg	Ni	Ti	Al
1	ATCu4MgTi	4,30	0,29	0,30	-	0,27	-	0,20	bal.
2	ATSi12CuNiMg	1,30	0,49	12,3	0,31	1,48	1,04	0,14	bal.

.The features of complementary phases. Table 2

Particles type	Granulation, x10^{-6}	Porosity, %	Chemical composition, % weight						
			C	S	SiO_2+ Si	Fe_20_3	Al_20_3	SiC	
Grafit	60	27	99,6	0,1	-	-	-	-	0,3
SiC	40	-	0,15	-	0,58	0,32	0,28	bal.	-

3. EXPERIMENTAL RESULTS

The liquid matrixn/non-metallic particles suspensions were prepared in the experimental conditions shown in Table 3.

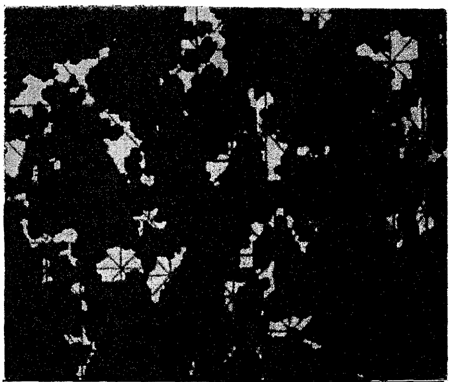
Experimental conditions used for the obtaining, of suspensions. Table 3

Exp. no	Metallic matrix		Complementary phase			Technological parameter			
	Alloy	Temperature (before stirring), [K]	Particles type	Particles addition,% wgt.	Pre-heating temperature,	Feeding rate [g/min]	Stirring time,[min]	Rotation spe rot/min	Casting temperature suspension,[K]
1	ATSi12CuNiMg	923	CGP	8,0	673	3,5	12	500	853
2		923	CG_P	8,0	673	4,2	12	500	853
3		923	CGP	8,0	773	5,1	12	500	853
4		923	CG_P	8,0	773	6,3	12	500	853
5		923	CGP	8,0	873	7,5	12	500	853
6		923	CG_0	8,0	873	8,6	12	500	853
7	ATCu4MgTi	973	SiCp	6,0	1073	3,0	10	300	973
8		973	SiCp	6,0	1073	4,2	10	350	973
9		973	SiC_p	6,0	1073	5,75	10	400	973
10		973	SiC_p	6,0	1073	6,6	10	450	973
11		973	SiC_p	6,0	293	8,0	10	500	973
12		973	SiCp	6,0	293	10,0	10	500	973

The MMCs obtained by experimental method shown previously were codified with teh 1, 2, 3, 4, 5, 6 numbers in case of ATSil2CuNiMg/CGp composites and with 7, 8, 9, 10, 11, 12 numbers for ATCu4MgTi/SiCp composites.

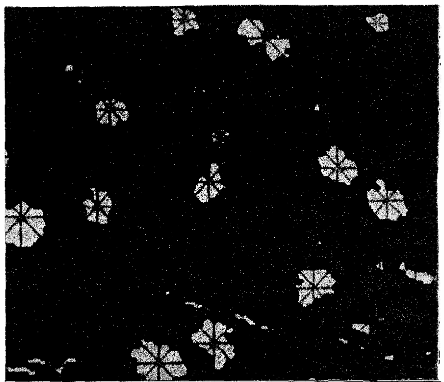
These composites were investigated by optical microscopy using an aquisition and image analyzing system consisted of MC-2 optical microscope, digital video camera, On computer and "METAFON" dedicated software.

The micrografies corresponding the composites obtained experimental are shown in Figure 1 and Figure 2, respectively.



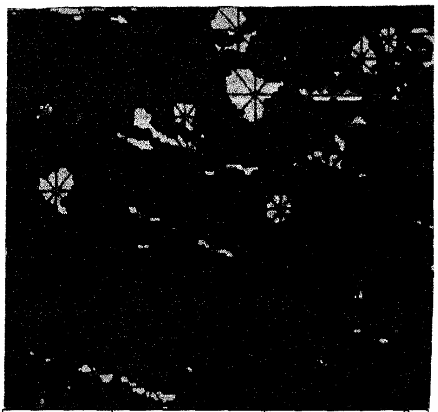
S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
7,2	72	68

a) experiment no.1, v_{ap}=3,5 g/min



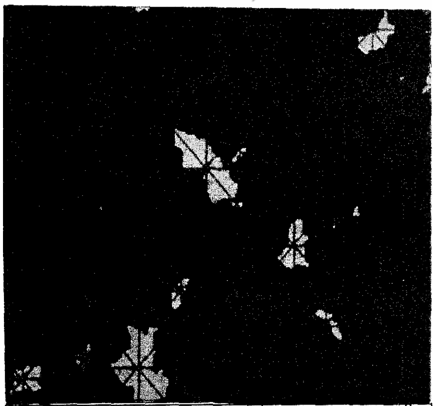
S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
6,0	78	61

b) experiment no.2, v_{ap}=4,2 g/min



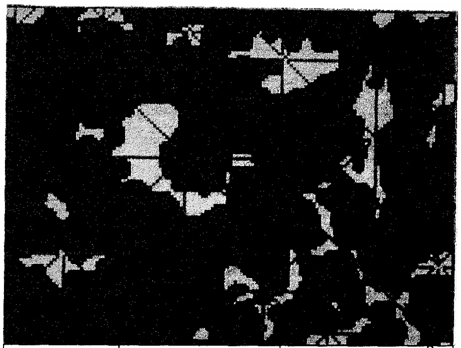
S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
5,3	78	58

c) experiment no.3, v_{ap}-5,1 g/min



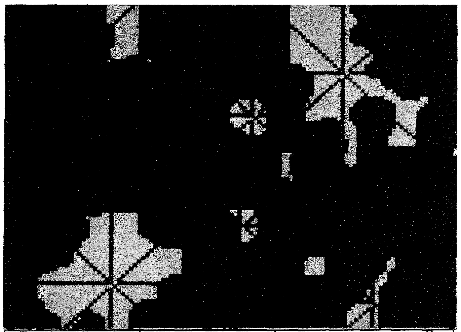
S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
4,8	80	45

d) experiment no.4 v_{ap}=6,3 g/min



S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
4,2	94	32

e) experiment no.5, Vap=7,5 g/min



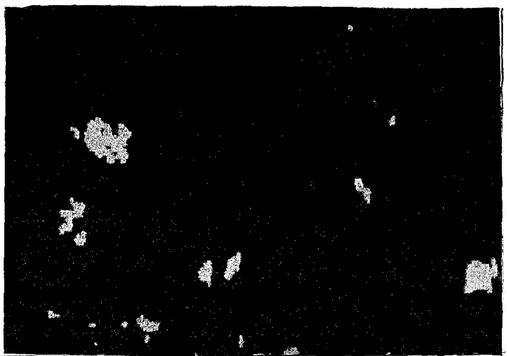
S_p, [%]	D_{mp},[μm]	N_p,[nr.part/mm^2]
3,6	100	23

f) experiment no.6, v_{ap}=8,6 g/min

Fig. l. The non-etches micrografies of ATSil2CuNiMg/CGp composites (x75); different feeding rates (v_{ap})were used during suspensions preparation.

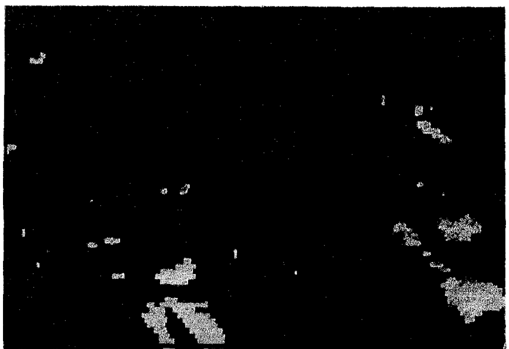
S_p, [%]	N_p,[nr.part/mm^2]
5,4	55

a) experiment no.7, v_{ap}=3,0 g/min



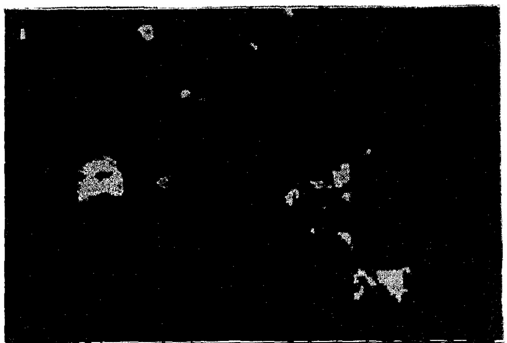
S_p, [%]	N_p,[nr.part/mm^2]
4,6	50

b) experiment no.8, v_{ap}=4,2 g/min



S_p, [%]	N_p,[nr.part/mm^2]
4,1	41

c) experiment no.9, v_{ap}=5,75 g/min

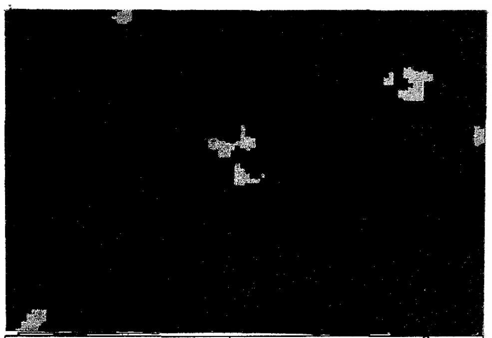


S_p, [%]	N_p,[nr.part/mm^2]
3,5	38

d) experiment no.10 v_{ap}=6,6 g/min

S_p, [%]	N_p,[nr.part/mm^2]
3,2	26

e) experiment no.l 1, v_{ap}=8 g/min



S_p, [%]	N_p,[nr.part/mm^2]
2,7	20

f) experiment no.12, v_{ap}=10 g/min

Fig. 2. The weak etches micrografies of ATCu4MgTi/SiCp composites (Keller agent, x75); different feeding rates (v_v) were used during suspensions preparation.

The surface areas of particles incorporated inside metallic matrix from investigated surface of composite samples, versus feeding rates of metallic melt with particles, vap, during suspension preparation are shown in Figure 3.

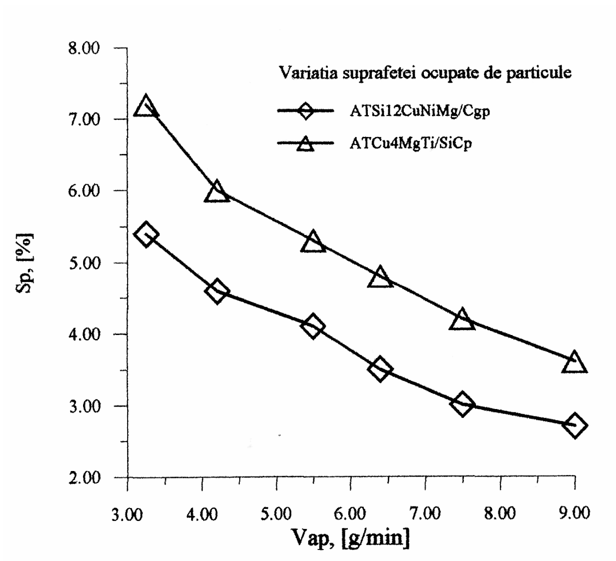


Fig. 3. The surface areas of particles incorporated inside metallic matrix.

4. CONCLUSIONS

The analysis of micrografies presented in Figure land Figure 2, as well as the analysis of graph from Figure 3 shown us that the incorporation of particles inside metallic matrix were much better for the low values of feeding rate. In case of composites reinforced with gaphite particles, the agglomerations with great sizes for high values of feeding rate were observed .

In case of composites reinforced with SiC particles the influence of feeding rate on particles incorporation inside matrix was not important.

A more uniform distribution of non-metallic particles was observed when the low values of the feeding rates were used. In these cases the stirrind times were greater so that the viscosity of suspensions decreased because of thixotropy phenomenon. Thus, the dispersion of non/metallic particles inside metallic matrix was much better.

The feeding rate of liquid metallic matrix with non-metallic particles is one in important technological parameters of the suspensions preparation, which has a considerable influence on the incorporation and dispersion of particles inside solid metallic matrix.

REFERENCES

[1] Roman, C, *Contribuţii privind obţinerea şi caracterizarea materialelor compozite cu matricea metalică şi particule,* Teză de doctorat, Iaşi, 2000.
[2] Brabie, V., Moldovan, P., Ştefănescu,F.L, Neagu, G., Cătălina, A., *Rolul fenomenelor de interfaţă la producerea compozitelor metalice,* Metalurgia, nr., 6,1992 p.37-42.
[3] Rana.F., Dhindaw, D.K.,Ştefănescu,D.M., *Optimisation of SiC Partide Dispersion in Aluminium Metal-Matrix Composites,* AFS Transaction, vol. 89, p. 41.