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RESEARCH REGARDING THE OBTAINING OF SOME COMPOSITE MATERIALS WITH METALLIC MATRIX FROM ALUMINIUM AND FeTi (32% Ti) REFRACTORY PARTICLES

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ABSTRACT

The aim of the paper is to create a composite material by a mechanical mixing method to be used in the field of steels elaboration in the deoxidizing and alloying stage.

KEYWORDS: composite material, Vortex method, ferroalloy

1. Introduction

The research objective was to find a method for the valorization of granular ferroalloy (FeTi32). Current ISO 5445/1995 standards require a grain with the lower limit of 3.5 mm for use in the development stage of deoxidation and alloying of steel.

The reintroduction in the steel making process of ferroalloy particle FeTi32 granular and powdery steelmakers reduces losses by the use of the particles.

Newly created composite materials have the intermediary densities the two initial density = 2.7 [g/cm^3][1] and FeTi32 bulk = 6.2 [g/cm^3][2]. This specific density is favorable for deoxidation process because the new material does not float in the slag area in the upper part ($\rho \sim 3$ g/cm^3) but descends in the metal bath of steel ($\rho \sim 6.9$ g/cm^3).

The combined deoxidation of steels has the advantages of placing in the same time a number of chemical elements in the metallic bath of steel; in our case are aluminum and titanium. [4]

2. Experimental procedure

The mechanical homogenization method used in the literature is called Vortex method.[5][6] This method consists of placing a pallet in the molten alloy. The blade rotates with a certain speed of rotation for a period of time designated by the experimental procedure [7].

Designing and making the experiment aimed to highlight the inclusion in different particle size classes of ferroalloy in aluminum metal matrix. So we varied the ferroalloy particle sizes (FeTi32) maintaining constant parameters: temperature, steering rate and chemical composition of particles. In one experiment we varied the mixing time and the mass.

Table 1. *Experimental data*

No.	Load composition			Ratio Al/FeTi32	Temperature	Mixing time	Steering rate
	Al	FeTi32 mass	FeTi32 grain				
	[g]		[mm]	[%]	[^{o}C]	[min.]	[rpm]
1	200	25	0.8	12.5	700	15	170
2	200	50	0.8	25	700	30	170
3	200	50	0.4	25	700	30	170
4	200	50	0.056	25	700	30	170

3. Results and discussions

The mechanical mixing process implies the movement of the particles in liquid aluminum. In the first part of the particle wetting occurs.

If the particles are not wetted by the melt they will not be embedded and will form a distinct phase which comprises partially wetted particles covered with a film of aluminum, particles located on the outside of the melt.

To better observe the behavior of the particle, they were being sorted by rank. Of all the particle size classes, were chosen three classes: 0.8 mm, 0.4 mm, 0.056 mm. These classes are representative particle size covering the entire spectrum of sizes from the finest to the coarsest.

The behavior of particles in contact with molten aluminum to form clusters is increasing this sense of their wetting time.

The behavior of particles in contact with molten aluminum is to form clusters, increasing the wetting time.

The mechanical mixing process is done in the furnace atmosphere that is composed of 78% nitrogen and 21% volume percent, the rest is composed of other gases.

The liquid aluminum contact with air quickly forms a film of Al_2O_3 which also slows the wetting process of assimilation of metal particles in the bath.

Another factor that competes in the dispersion of particles in molten aluminum mass is the mass transport of particles and energy from the molten aluminum and vice versa.

In the case of energy transport there are two phases of different natures, they will have different properties and thermal conductivity.[3]

Table 2. *Thermal conductivity coefficients*

No	Chemical composition [%]	Thermal conductivity [W/m K]
1	Al	237
2	FeTi with 32% Ti	0.6

Therefore after the introduction of molten metal particles, there will be a slight initial decrease in the melting temperature. Aluminum cooling effect will be observed by increasing the dynamic viscosity of aluminum.

Mass transfer occurs by diffusion process between the two phases of liquid aluminum particles FeTi.

The interface matrix - particle diffusion process takes place. But as the mixing process continues over a relatively short distance, diffusion takes place locally. To emphasize the diffusion, we can analyze the chemical composition. For particle sizes of 0.8 mm elaborated at 15 min and 30 minutes are found different chemical compositions.

For the probes obtained, we have the following determinations:

a. Chemical analysis

We use X-rays fluorescence spectrometer (XRF) Innov-x system Alpha Series. The X-ray spectrometer has a 10 mm aperture size which represents the X-ray window and the analysis is done by bombarding the surface with X-rays and their detection on the surface.

Spectrometer computer calculates an average of all points on the sample and gives the result. So the stirring time increases the contact time between aluminum particles and thus increases the interface and surface diffusion.

Table 3. *Chemical composition*

No.	Grain	Chemical analysis		
		Al	Fe	Ti
	[mm]	[%]		
1	0.8	91.22	5.53	3.25
2	0.8	77,51	13,64	8.82
3	0.4	79.36	13.08	7.56
4	0.056	76.71	13.54	9.75

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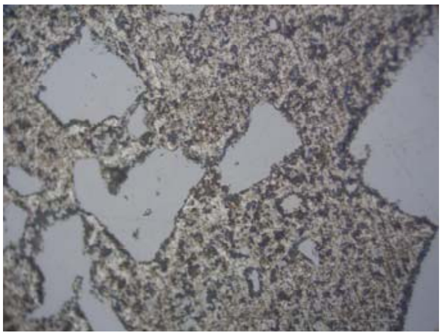
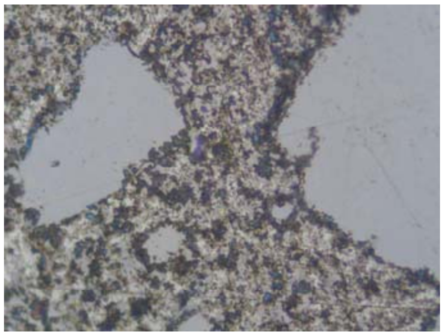
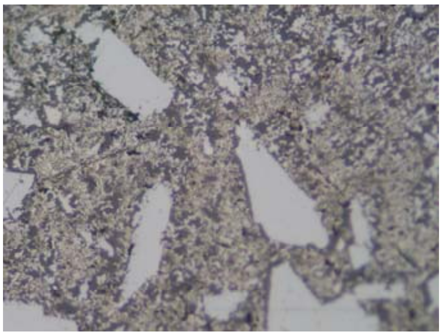
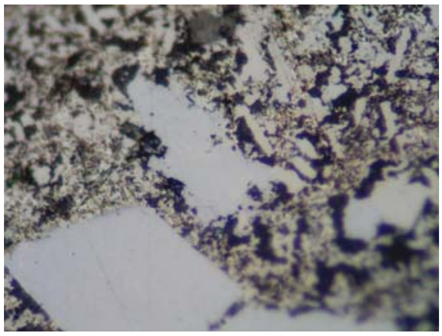
b.Metallographic analysis

For this, we collected samples of the composite material Al/FeTi with 32% Ti and we have prepared it by grinding and by polishing the samples.

Fig. 1. *Microstructures of Al/FeTi32*

No.	Ferroalloy particle diameter, FeTi32	Process time	Microstructures	
			un-attacked	
	[mm]	[min]		
1	0.800	30	 X400	 X1000
2	0.056	30	 X400	 X1000

Upon implementation of metallographic analysis we can make the following observations:

- for 0.8 mm particle size:

- good adhesion between matrix and particles;

- at the interface liquid - particle not formed a counter-diffusion zone;

- particles shows the layout predominantly polygonal and they are dispersed in the matrix relatively homogeneous;

- 0.056 mm particle size:

- good adhesion between matrix and particles;

- at higher magnification we see the interface and any casting defects (micro porosity).

Metallographic appearance reveals very different sizes which would lead to the conclusion that it was not finished size ranked the ferroalloys. This would explain the fact that the shape of the particles is what makes platform break is sometimes great, sometimes through the booklet to be slanted and appear almost acicular issues.

Metallographic aspects have sometimes shadows at the particle-matrix interface and that suggests an incorporation of non-compliant but this is because at the processing of samples FeTi32 particles remain slightly raised from the aluminum matrix and the incident rays from lens of the microscope can create this optical illusion.

4. Conclusion

Mechanical mixing is the main factor in obtaining a composite material Al/FeTi32. Mechanical mixing process was done by the literature method called Vortex. Mixing time is to allow each particle to come into contact with liquid aluminum.

Demonstrated by the different chemical composition at 15 min and 30 min. Microscopic analysis showed the appearance of the interface Al/FeTi32. Here he could find that the diffusion zone is very limited.

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