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Research paper



Investigations on Mechanical Behavior of Al6061-TiO_2-SiC Produced by Stir Casting

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Abstract

Fine mechanical and thermal properties of metal matrix composites make them more demanding in various fields such as automotive, aerospace and structural applications. In this paper an effort has been made to fabricate a metal matrix composite, Titanium-di-oxide and silicon carbide reinforced in Al 6061 matrix using stir casting method. The reinforcements were added in 2%, 4% and 6% of weight to Al6061 to fabricate the metal matrix composite. Castings were machined and the specimens were prepared for various testing. Mechanical properties such as tensile strength, hardness, and corrosion analysis were studied for various compositions of reinforcements. And then the reinforcement was analyzed and studied for the improvement of mechanical properties in the material.

Keywords: *Aluminum 6061; Stir Casting; Tensile test; Hardness; Corrosion test.*

1. Introduction

Composite materials are one in every of the most important areas of scientific and applied analysis for several decades; but, solely within the past decade they need to be been viewed and applied as engineering materials. Nowadays we've got vital progress and advances in our understanding of those materials and their metallurgic behavior. The best advantage is within the incontrovertible fact that we are able to inherit properties of each, the metal matrix and therefore the reinforcements, providing a cloth with properties which might meet specific and difficult needs in several applications. Most of the work has been handling atomic number 13 and different light-weight metal matrices for applications requiring light-weight weight together with high strength and stiffness. Though producing of continuous fiber strengthened atomic number 13 matrix composites is very difficult and high-priced they're used during a few applications, particularly within the region business. However, nowadays most of the stress is placed on up the value potency of production techniques for particulate strengthened atomic number 13 matrix composites that have moderate properties however they're far cheaper than continuous fiber strengthened materials. MMCs have bound superior mechanical properties, particularly higher transversal strength and stiffness, larger shear and compressive strengths and higher warm temperature capabilities. There are benefits in a number of the physical attributes of MMCs like no vital wetness absorption properties, flammability, high electrical and thermal conductivities, and resistance to most radiations. Metal matrix composites are extensively studied for a few years, the first support has returned from the region business for frame and craft elements. A lot of recently, automotive, physical science and recreation industries are operating diffusively with composites.

2. Experimental Procedure

Experimentation is done. The coding is similar to that of C language. The experimentation on the coding has been performed for many number times in order to calculate the proper results

2.1. Material

Table.1: Chemical Composition of Al6061 alloy [wt. %] designated as a base alloy

Elements	Weight percentage %
Zn	0.3
Mg	0.8-1.2
Cu	0.15-0.40
Si	0.4-0.8
Fe	1
Mn	0.2
Ti	0.2
Cr	0.04-0.35
others	0.05
Al	Balance

2.2. Preparation of Al 6061-TiO_2-SiC Based Metal Matrix Composite By Stir Casting

Stir casting is one amongst the foremost economical strategies of process MMC's attributable to its simplicity, flexibility, and pertinency to the profusion of production. At first in a stir casting method, Al6061 matrix metal was heated in a very element melting pot. The chamber temperature raised to 750 °C and maintained till the matrix material liquid utterly, at this stage metal was accessorial to get rid of the scum and therefore the entrapped gases then reinforcing particles area unit accessorial into melted Al6061 at

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elevated temperatures at the side of the mechanical stirring. The melted alloys, with reinforcing particles area unit stirred around 2-3 minutes to get uniform distribution of reinforcements. The stirring was done victimization the four blade stirrer, that is driven by a variable speed motor with 750 rpm then the melted mixture was poured within the preheated die to organize the casted half and it had been allowed to solidify after solidification process castings were separated from the die. Once cooling the desired casting was obtained. Titanium-dioxide (TiO_2) and carbide (SiC) were accessorial as a strengthened in Al6061 matrix victimization stir casting technique. The reinforcements were accessorial in 2%, 4% and 6% of weight to Al6061 to fabricate the metal matrix composites.



Fig.1: Melting of Al6061 and Stir casting process





Fig.2: Specimen before Tensile test Fig.3. Specimen after the Tensile test

3. Results and Discussion

3.1. Tensile Test

Tensile test data for the each materials i.e. Al6061, 2% TiO_2-2%SiC, 4% TiO_2-4%SiC, 6% TiO_2-6%SiC and pure aluminium alloy were depicted in Table3. It was observed that the amount of tensile strength, elongation, and breaking load by MMC prepared with 6%TiO_2-6%SiC, is higher in comparison to the other materials. The maximum tensile strength was obtained at 6% of TiO_2-6%SiC addition in Al 6061, the value is 204 N/mm^2 at minimum is obtained at for pure aluminium, the value is 167 N/mm^2 Data from tension test had also shown the highest strength value for MMC prepared with 6%TiO_2 - 6% SiC than the other three materials. Sometimes decreases due to porosity occur during casting. The improvement in the tensile strength can be attributed to the fact that the TiO_2-SiC possess higher tensile strength and its presence in the matrix improves the tensile strength of the composite.

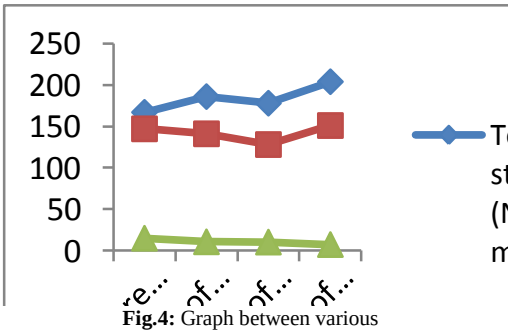


Fig.4: Graph between various

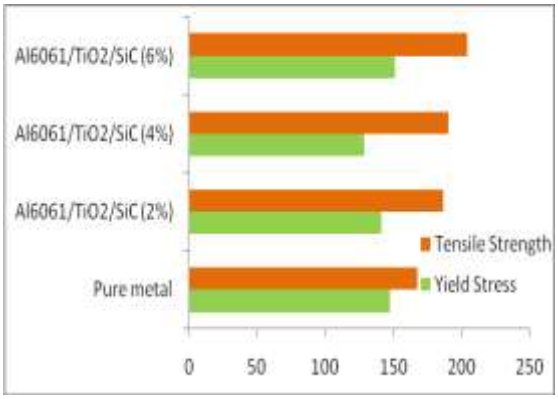


Fig.5: Graph between Tensile strength and Yield Stress

Table.2:

Material	Pure metal	Al6061-TiO_2 SiC (2%)	Al6061-TiO_2 SiC (4%)	Al6061-TiO_2 SiC (6%)
Ultimate Load in kN(P_u)	5.805	6.26	6.085	7.235
Yield Stress N/mm^2(σ_y)	147	141	128	151
Tensile Strength in kN(P_t)	167	186	178	204
Elongation in mm (δ) (%)	14.66	10.33	10	07

3.2. Hardness Test

The result indicates that the hardness of the Al6061-TiO_2-SiC composite material increases as the content of TiO_2-SiC increased the improvement in the hardness can be attributed to the fact that the TiO_2-SiC possess higher hardness and its presence in the matrix improves the hardness of the composite.

Table.3:

Sample	Material	Trial 1	Trial 2	Trial 3	Mean Hardness (HRC)
Sample 1	Pure metal	63.9	59.9	61.6	61.8
Sample 2	Al6061/TiO_2/SiC (2%)	62.2	62.3	63.5	62.6
Sample 3	Al6061/TiO_2/SiC (4%)	62.9	63.6	63.5	63.3
Sample 4	Al6061/TiO_2/SiC (6%)	64.9	65.9	62.5	64.4

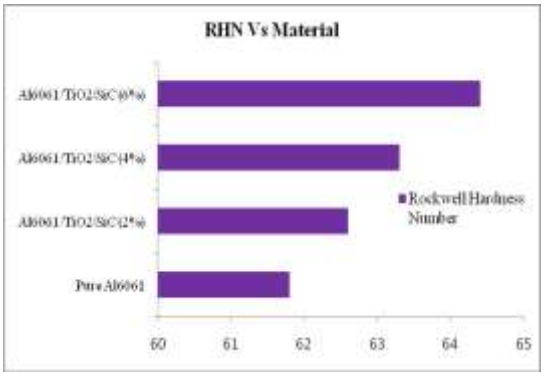


Fig.5: Graph between Various materials Vs Hardness

3.3. Corrosion Behavior

The corrosion behavior of 6061 aluminum alloy was tested in different concentrations of phosphoric acid medium and sodium hydroxide medium at different temperatures. The study was done by an electrochemical method. It was found that

Sample	Sample 1	Sample 2	Sample 3	Sample 4
Density (g/cm3)	2.83	2.75	2.844	2.76
Volume (cm3)	3.174	3.174	3.174	3.174
Weight before corrosion (g)	9.003	8.705	9.027	8.766
Weight after corrosion (g)	9.002	8.703	9.025	8.765
Weight loss(g)	0.001	0.002	0.002	0.001
Corrosion rate (mm/year)	3.2*10-6	6.58*10-6	6.369*10-6	3.281*10-6

4. Conclusion

Al6061-TiO_2-SiC MMCs were made-up victimization stir casting technique. The results of TiO_2-SiC content on mechanical properties were analyzed. The casting of Al6061-TiO_2-SiC will be done by stir casting method For casting of composite by stir casting method stirring speed, temperature, time, reinforcement heat temperature, particle incorporation rate, are the necessary method parameters. final enduringness is augmented with the rise inTiO_2-SiC concentration within the composite at totally different concentration of TiO_2-SiC we tend to get,167 N/mm^2 at pure Al6061, 186 N/mm2 at a pair of,178 N/mm^2 at 4% and 204 N/mm^2 at 6% however typically decreases owing to consistency happens throughout casting. Hardness is augmented with the augmented in numerous concentrations of TiO_2-SiC we tend to get 61.8 RHN at pure Al6061, 62.6 RHN at 2%, 63.3 RHN at 4% and 64.4 RHN at 6%.

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