Topological Surface of Aluminium 7075 and Zirconium Composites

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Abstract. Aluminum alloys such as 7075, which are extensively used in aircraft structures, render them highly susceptible to corrosion. Corrosion can adversely affect aircraft structural integrity since fatigue cracks can nucleate from corrosion pits and grow at an accelerated rate in corrosive environment. The engineering machines and mechanical components are subjected to fluctuating stresses, taking place at relatively high frequencies and under these conditions failure is found to occur. The main objective is to fabricate Metal Matrix Composite using stir casting machine and Surface Finish of AL7075 with Zirconium and SEM is analyzed. The Composite materials are aluminum mixed with different compositions of 1%, 2%, 3% Zirconium.

Keywords: Metal Matrix Composites Stir Casting Process, AL 7075, SEM, 1%, 2%, 3% Zirconium

1. Introduction

The composites are most adaptable and advanced engineering materials. Material science and technology has fast progressing with composite materials. The material is mixer of two or more and having bulk properties. [1] The composite gives rise to their shape, environmental tolerance, surface appearance and overall durability. [3] The outstanding wear resistance for longevity and reduced Maintance low coefficient of thermal expansion for dimensional stability components and structures made from ceramic reinforced metal by casting or infiltration processes are being used in products for robotics, industrial process equipment, aerospace, electronic packaging, mechanical instrumentation and automotive applications. Metal matrix composites (MMCs) are rapid increase in research and becoming attractive materials for advanced aerospace applications because their properties can be tailored through the addition of selected reinforcements. The addition of different materials with different composition like graphite, Magnesium and Silicon etc concluded that Metal Matrix composite strength are increasing more than usual [2]. Metal matrix composites have a market potential for various applications, particularly in the automotive industry where the pressure to use lightweight materials has increased because of environmental issues. Components that have been manufactured using metal matrix composites include pistons for diesel engines and connecting rods.

Table 1: Chemical Composition of Aluminium Al 7075

Element	Percentage	Element	Percentage
Si	0.4	Cr	0.28
Cu	2	Ni	-
Mg	2.9	Zn	6.1
Mn	0.3	Ti	0.2
Fe	0.5	Zr	-
		Al	Remainder

Table 2: Properties of Al 7075 and Zirconium

Properties	Density	Melting point	Tensile/ Compressive Strength	Fatigue/ Bending strength	Hardness/ Vickers Hardness	Boiling Point
Al 7075	2.8 g/cc	483^0 C	220 MPa	160 MPa	60	Nil
Zirconium	5.81 g/cm^3	2700^0 C	3500 – 5600 MPa	600 – 1400 MPa	1250 – 1300 HV	5500^0 C

2. Methodology

Stir casting process is a simplest and cost effective liquid state fabricating method of metal matrix composites, in which a distributed phase is mixed with a molten matrix by means of mechanical stirring which ensures a more uniform distribution of the reinforcing particles. The process aluminium alloy was superheated to 800°C and then the temperature is lowered gradually below the liquids temperature to keep the matrix material in the semi-solid state. The preheated zirconium particles with different volume proportions stirrer and composite slurry temperature increased to completely liquid state, automatic stirring was continued to about ten minutes at an average stirring speed of 300-350 rpm. The melted material then superheated above liquids temperature and finally poured into the permanent mould for preparing testing specimen.

3. Experimental Procedure

Placing aluminum material 7075 in sand mould and heating the material upto to its standard melting point. The aluminum 7075 material in stir casting machine and placing the cotton at the top of lid so that no temperature is lost to surroundings of furnace and also to the environment. The temperature in the stir casting machine is set up to 760 o c so that total aluminium material block melts into liquid state.

Preheating zirconium nano particles (powder) up to 3260C in muffle furnace so that the zirconium nano particles can mix with aluminum 7075 materials very effectively. Pouring the preheated zirconium powder into molten metal as per the composition at 760c.The zirconium powder is only added to the molten aluminum while stirrer is on. The zirconium powder is added only as per composition calculated taking density as base value.

Table 3: Weight % of Materials used in Experiment

SL.NO.	% of Al 7075 by weight	% of Zro_2 by Weight
1	100	-
2	99	1
3	98	2
4	97	3

Stirring the mixture both molten aluminum in addition to added zirconium percentage using stir casting machine stirring should be carried for 2-3 minutes so that a total nano particle of zirconium powder is perfectly mixed with molten aluminum**.** After finely mixing the composition for couple of minutes remove the molten composition from sand mould (casting machine) and pour the molten metal directly into the already prepared pattern.
The patterns cool for some time at room temperature so that patterns can easily removed after releasing lock by which is present at side of pattern.

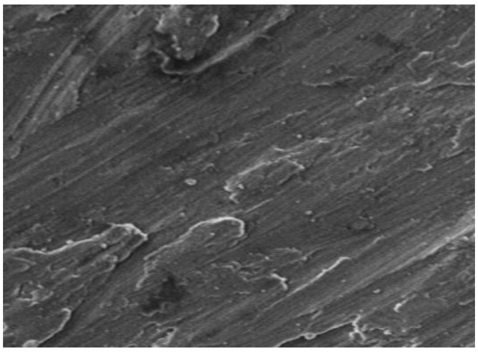
Figure 1: Stir Casting Machine

Figure 2: Inside View of Stir Casting Furnace

Figure 3: Specimen for Tensile testing as per ASME standards

4. Results and Discussion

The surface topology of work materials Aluminium 7075 Zirconium are shown in the SEM photographs of Fig: 4. and Composite materials which are casted by stir casting method in Fig. 5 (a, b, c) are Al7075 with 1%, 2%, and 3% Zirconium.



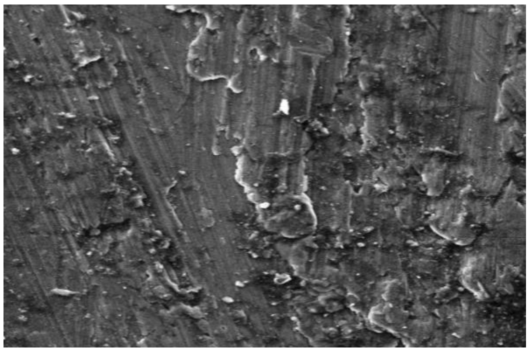
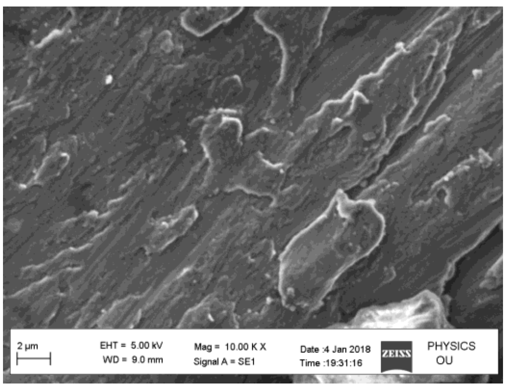
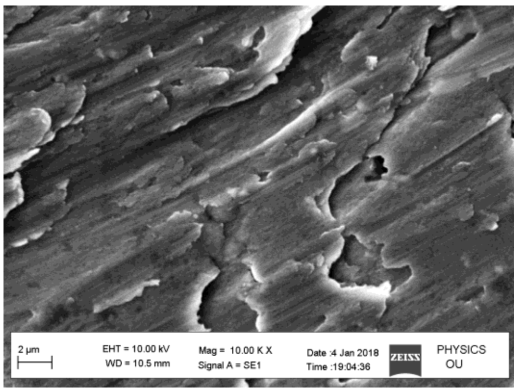


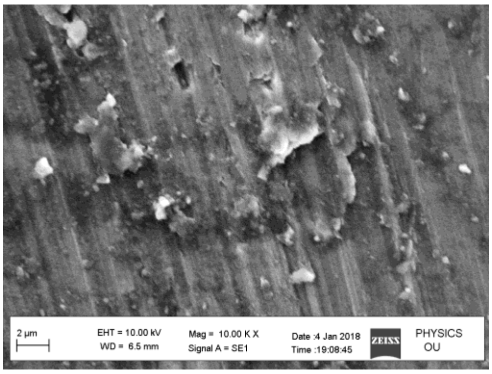
Figure 4. (a) ALUMINUM 7075 (b) ZIRCONIUM



(a)



(b)



(c)

Figure 5. SEM Photographs the % of Zirconium in Al 7075 (a) 1%, (b) 2%, (c) 3%

4.1 Characteristics of the Zirconium in Al 7075 surfaces

The morphology of the surfaces of Zirconium in Al 7075 is shown in a Fig. 5 which shows considerable dissimilarity in the three cases. The mechanism of the Fig. 5 (a) case is seen to be thermal from melting heat. The surface exhibits retained and resolidified metal with imperfect expulsion. However the surface exhibits higher turbulence from effective expulsion of liquid metal. The structure of Fig. 5 (a) and (b) show the similarity in flakes and mixture Zirconium and Al 7075 where in Fig. 5 (c) show very good mixture of Zirconium and Al 7075 and layer is very closely packed.

5. Conclusion

- Stir Casting has considerably lower erosion rates.
- The 2% and 3% Zirconium show carbon deposits.
- Surface irregularity follows normal pattern near top surface of 1% Zirconium.
- Considerable resoldified also exhibits typical features of gas pockets in 2% and 3% Zirconium.

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