Corrosion & Wear Resistance OfAL6061-Basalt And Zircon Hybrid Composite Material In Acid Media

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Abstract. The present investigation is an attempt made to develop Al6061/Basalt/Zirconium oxide Hybrid Metal Matrix Composites (MMCs) by liquid metallurgy technique (stir casting) and to study the wear properties of Al6061/Basalt/Zirconium oxide reinforced hybrid metal matrix composites. The composite is prepared by using Liquid Metallurgy Route (Stir Casting Technique), although other processing technique such as powder metallurgy produces better mechanical properties in MMCs, Liquid state has some important advantages such as better matrix particle bonding, easier control of matrix structure, simplicity, low cost of processing, nearer to net shape components and wide selection of material. Al6061 is taken as a base matrix and Basalt (1-10%) and Zirconium oxides (2%) are used as reinforcements. Corrosion analysis for Aluminum Metal Matrix Composites (MMCs) was done in acid (HCl) media at room temperature & different time intervals. The results were tabulated & it was found that the MMC containing 4% basalt under went maximum corrosion at room temperature. SEM is done for all the samples the results are tabulated.

Keywords:- Particulate reinforcements MMC, Stir Casting, Hybrid Composites, and Basalt

1. INTRODUCTION

Conventional monolithic materials such as metals and their alloys, ceramic, polymer materials cannot meet all the properties such as combination of strength, stiffness, density, toughness and better corrosion resistance properties, which are essential for many of the modern industrial applications. Thus, these major limitations of the conventional metals paved the way for new class of metals known as COMPOSITE MATERIALS[1,2,3,4].

The word composite in the term composite material signifies that two or more dissimilar materials are combined on a macroscopic scale to form a useful third material. Thus on a broad sense composites can be defined as “A combination of two or more materials, differing in form or composition on a macroscopic scale”. However the constituents retain their identities, i.e. they do not dissolve or merge completely in to one another, although they act incontent.

Thus from the definition of composites it is clear that composites are made up of individual material referred to as constituent materials. Out of these constituent materials one is continuous phase and is called as MATRIX, while the second one being discontinuous phase and it is termed as REINFORCEMENT. The continuous phase surrounds and supports the reinforcement material by maintaining their relative position.The reinforcement is selected based on their inherent properties like corrosion resistance, oxidation, stiffness and other properties, while matrix acts as a bonding element.

Aluminum and its alloys are the most extensively utilized matrix metal because of their availability, light weight, ease of fabrication and fairly high mechanical properties. Also review of the past researches indicates that in recent years, among all the Aluminum alloys, Al6061 is gaining much popularity as a matrix material to prepare MMCs owing to its excellent mechanical properties and good corrosion resistance. In addition, Al6061 alloy is also heat treatable and can be formed by secondary processing; as a result, further improvements in strength and other properties can beexpected.One of the reinforcement chosen in this work is Basalt. Basalt a name derived from the Latin for 'very hard stone', basalt is indeed a very hard, black igneous rock found all over Earth and our solar system. It most commonly forms as an extrusive rock, such as a lava flow, but can also form in small intrusive bodies, such as an igneous layers or a

thin sill. It has property like thermal resistance, and wear resistance[5,6,7,8].

2. EXPERIMENTAL

Gravity weight loss corrosion test as per ASTM standards is followed in our work. The specimens of the casted Hybrid Metal Matrix Composites are made and cut into 8 x 25 mm size cylindrical specimens by standard metallographic techniques shown in figure 1A,1B,. The specimens are finely ground with silicon carbide paper 1000 grit and washed with water and acetone, then dried and weighed using electronic balance up to third decimal place.

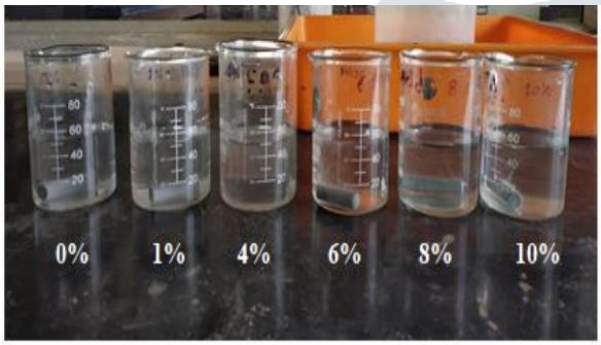

Fig 1A: Experimental setup of corrosion test

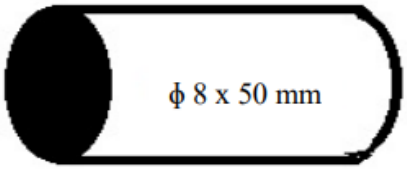

Fig 1B: Standard wear test specimen

Weight loss corrosion studies are conducted for the specimens prepared as mentioned above in the 1 molar Hydrochloric acid solution (1M HCl) at room temperature using conventional weight loss method according to ASTM 69-80. The tests are conducted up to 96 hours in steps of 24 hours. Six numbers of 250cm^3 glass beakers are taken and known quantity of 1M HCl is added to the beaker. The specimens are weighed and the samples are immersed in 1M HCl solution and taken out after 24 hours. The specimens after exposure to corrosion medium, the same sample is dipped in Clarke's solution and gently cleaned with a brush to remove the oxide layer formed on the specimen. Specimens are then washed with distilled water and acetone then it is dried, after drying the specimens were weighed by using digital weighing machine and the final weight is compared with the initial weight. The same procedure is conducted for 96 hours with an interval of 24 hours.

3. COROSSIONTEST RESULTS

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.3979	3.2609	0.137
48	3.2609	3.0754	0.1855
120	3.0754	2.7605	0.3149
144	2.7605	2.6753	0.0852
168	2.6753	2.5854	0.0899
192	2.5854	2.4464	0.112
216	2.4464	2.2707	0.1757
240	2.2707	2.1615	0.1092

Table 1: Tabulated test results for Al6061+ 0% Basalt+0% ZrO_2

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.4975	3.3294	0.1681
48	3.3294	3.1614	0.168
120	3.1614	2.9026	0.2588
144	2.9026	2.8162	0.0864
168	2.8162	2.6956	0.1206
192	2.6956	2.5600	0.1356
216	2.5600	2.4324	0.1276
240	2.4324	2.3154	0.117

Table2: Tabulated test results for Al6061+ 1%Basalt+2% ZrO_2

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.4218	3.2362	0.1856
48	3.2362	3.0152	0.221
120	3.0152	2.4717	0.5435
144	2.4717	2.3104	0.1613
168	2.3104	2.1640	0.1464
192	2.1640	1.9287	0.2353
216	1.9287	1.7495	0.4337
240	1.7495	1.6225	0.127

Table 3: Tabulated test results for Al6061+ 4% Basalt+2% ZrO2

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.3001	3.1766	0.1235
48	3.1766	2.9987	0.1779
120	2.9987	2.6362	0.3625
144	2.6362	2.5153	0.1209
168	2.5153	2.4149	0.1004
192	2.4149	2.2525	0.1624
216	2.2525	2.1299	0.1226
240	2.1299	1.9952	0.1347

Table 4: Tabulated test results for Al6061+ 6% Basalt+2% ZrO2

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.3003	3.1789	0.1214
48	3.1789	3.0336	0.1453
120	3.0336	2.7046	0.329
144	2.7046	2.6363	0.0683
168	2.6363	2.5172	0.1191
192	2.5172	2.3587	0.1585
216	2.3587	2.2407	0.118
240	2.2407	2.1043	0.1364

Table 5 : Tabulated test results for Al6061+ 8% Basalt+2%ZrO2

Time duration in hours	Initial wt in grams	Final wt in grams	Wt loss in grams
24	3.4601	3.3401	0.12
48	3.3401	3.1870	0.1531
120	3.1870	2.8463	0.3407
144	2.8463	2.7769	0.0694
168	2.7769	2.6748	0.1021
192	2.6748	2.4966	0.1782
216	2.4966	2.3561	0.1405
240	2.3561	2.2402	0.1159

Table 6: Tabulated test results for Al6061+ 10% Basalt+2%ZrO2

4. SEM RESULTS FOR THE TEST SPECIMEN

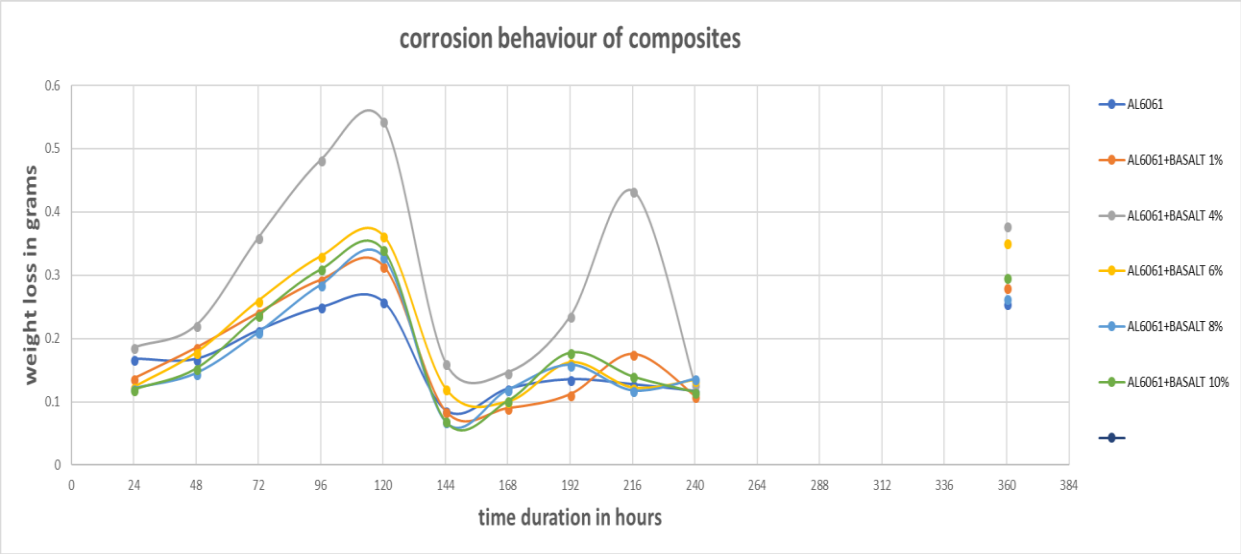

Fig 1C Corrosion Behaviour In Different Percentage of Basalt jn Composite

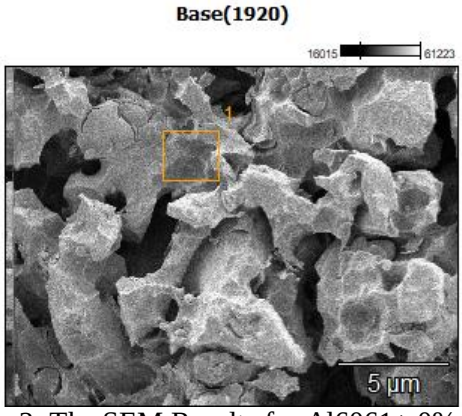

Fig 2: The SEM Results for Al6061+ 0% Basalt+0% ZrO2

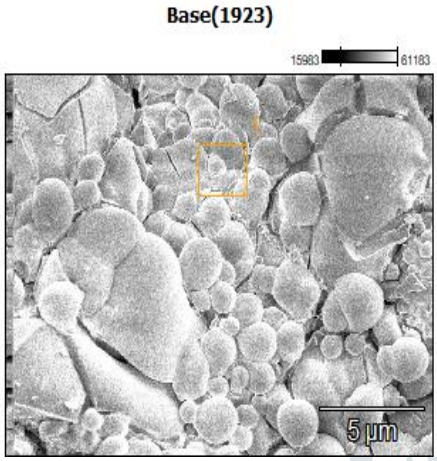

Fig 3: The SEM Results for Al6061+ 1%Basalt+2% ZrO2

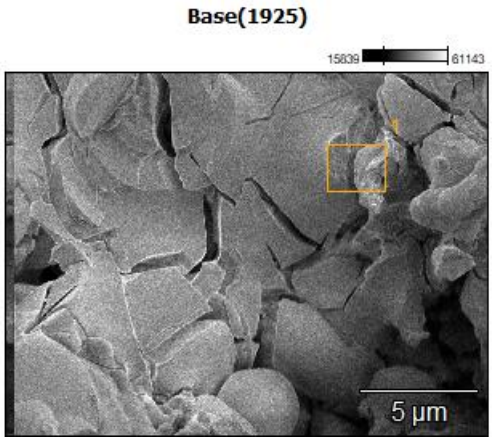

Fig 4: The SEM Results for Al6061+ 4% Basalt+2% ZrO2

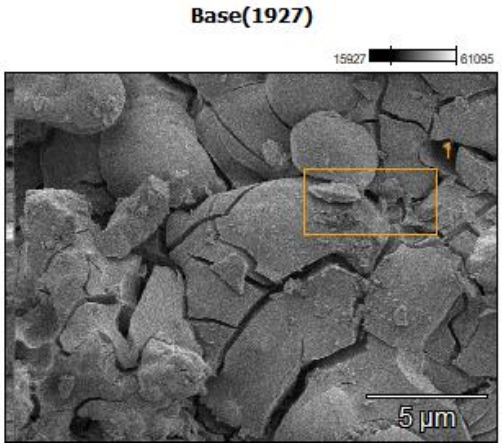

Fig 5: The SEM Results for Al6061+ 6% Basalt+2% ZrO

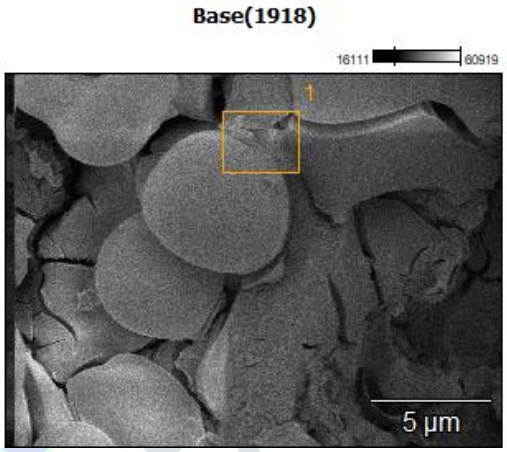

Fig 6: The SEM Results for Al6061+ 8% Basalt+2%ZrO2

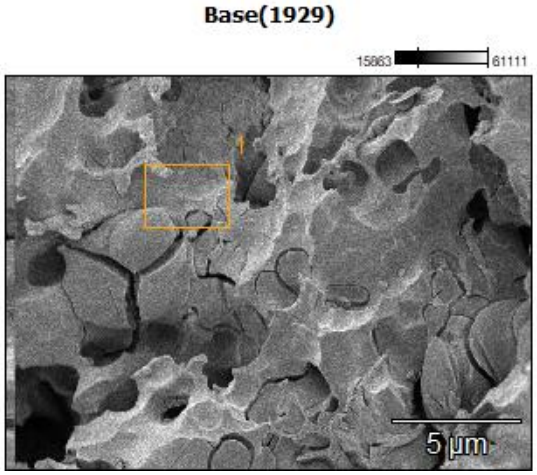

Fig 7: The SEM Results for Al6061+ 10% Basalt+2%ZrO2

5. CONCLUSION

- From the SEM Results the as the material used for corrosion test is a worn out material(Wear Tested Specimen) the cracks and cavitys are more which might have leads to little high corrosion rate.

- The Al6061/Basalt/ZrO2 Hybrid Metal Matrix Composites have been successfully evaluated for corrosion test, the two peaks are because of long duration of corrosion in the same 1 molar HCl solution media.

- The Al6061/Basalt/ZrO2 Hybrid Metal Matrix Composites have been successfully evaluated for corrosion test of 1 molar HCl solution. In which the corrosion is minimum in 0,8,10% and maximum for 4% compared to other. By this we can conclude that as basalt particles powder consist of maximum percentage of SiO2 .the corrosion rate has increasedrapidly.

- Basalt particulates and Zirconium can be successfully used as reinforcing materials for light weight Metal Matrix Composites (MMCs) .It can replace other higher density and expensive reinforcements. Also results in a 'lighter composite material'. Hence these composites canbe

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