Ductility and Fractography of Al-7075-BA Hybrid Composites

Mohammed Imran[1] Dr. A. R Anwar Khan[2]
[1]Research Scholar [2]Head of Dept.
[1,2]Department of Mechanical Engineering
[1,2]Ghousia College of Enginnering-Ramanagaram-562159, Affiliated VTU, Karnataka, India

Abstract— Aluminium 7075 alloy (Al-7075) has multiple applications from 1943, it needs improvements in mechanical properties of alloy. Past few years enhancing alloy properties by adding agricultural waste ashes, graphite (Gr), and SiC etc. as reinforcements. In present investigation Al-7075 alloy used as base material, reinforcements are sugarcane bagasse ash and Gr materials. 1, 3, 5, 7, 9, 11 & 13 wt% of BA reinforcement added in base metal to prepare Al-BA composites by using stir casting technique. The Gr reinforcement added in base metal 5wt% kept constant with various wt% of BA composites, which shows more enhancements in the mechanical properties of material. The mechanical properties analysed such as ductility by using percentage elongation and micro-fracture using SEM. Results are observed that, the mechanical strength increased i.e. ductility and fracture strength with increasing wt% of percentage BA reinforcement in base material of composite. Further, when 5% Gr particles added ductility, fracture strength and interfacial bonding strength increased in hybrid composites.

Key words: Al-7075, Baggase-Ash, Graphite, Ductility, Fractography

I. INTRODUCTION

AMCs (Aluminum matrix composites) are the expert material in the industrial world, because of its outstanding mechanical properties. AMCs is generally used in aerospace, marine and automobiles. [1-11]. Researchers, especially concentrating on defence application. Continuously determined hard materials and using suit their specific requirements [3]. Improvement in production of composites in application seen relatively low production cost. Among the various multiple ceramic Bagasse ash (BA) used as reinforcements. Cost free environmental free, pollution free available reinforcement say as BA. The high processing temperature causes decomposition of ceramic particles and the formation of brittle compounds because of the effect maintaining 750^0-800^0C for the fabrication of composites. Among the various manufacturing processes, the conventional stir casting is an attractive processing method for producing AMCs [7] as it is relatively cheap and offers a wide selection of materials and processing conditions and suitable for mass production and production of complex profiled composite components without damaging the reinforcement particles. Due to these salient features of stir casting method, recently many attempts have been made to produce different composites using this method [1,3].

II. EXPERIMENTAL DETAILS

A. Selection of Matrix Material

The selection and synthesis of Al7075 composites with graphite and BA reinforcements are as follows.

1) Al7075 alloy
2) Al7075 alloy + 1%BA
3) Al7075 alloy + 3%BA
4) Al7075 alloy + 5%BA
5) Al7075 alloy + 7%BA
6) Al7075 alloy + 9%BA
7) Al7075 alloy + 11%BA
8) Al7075 alloy + 13%BA
9) Al7075 alloy + 5%Gr + 1%BA
10) Al7075 alloy + 5%Gr + 3%BA
11) Al7075 alloy + 5%Gr + 5%BA
12) Al7075 alloy + 5%Gr + 7%BA
13) Al7075 alloy + 5%Gr + 9%BA
14) Al7075 alloy + 5%Gr + 11%BA
15) Al7075 alloy + 5%Gr + 13%BA

The composites were fabricated by using Al electric furnace. The compositions were melted in the furnace at 750^0C (temperature). The molten Al alloy was stirred by using mechanical rotating stirrer at 200-300 rpm for the duration of 10-15 minutes and then the reinforcement was added in the molten metal. The composites melting temperature of 750^0C maintained and it was then poured in to metallic moulds and allowed for the solidification. Machining was done using lathe as per the ASTM standard.

B. Experimental Tests

Evaluation of ductility with the help of percentage elongation of material of composites Strain rate constant 0.5mm/min was used during the tests in UTM machine. Investigation of fractured surface behaviour of composites using scanning electron microscopy (SEM).

III. RESULT AND DISCUSSIONS

A. Ductility

The percentage elongation test was conducted as per the ASTM E8M standard for composites. Aluminum with bagasse ash reinforced composites increasing ductility with increasing BA content. Al /5% graphite added with bagasse ash reinforced hybrid composites more increasing ductility with increasing BA content more than Al-BA composites and base metal shows in fig.1. The percentage elongations were increased with increasing in BA reinforcement, it was found that higher ductility of Al-5%Gr-BA hybrid composite than Al-BA composite material (fig.1) because wettability of melt and interfacial bonding is increased by the addition of Gr particles.

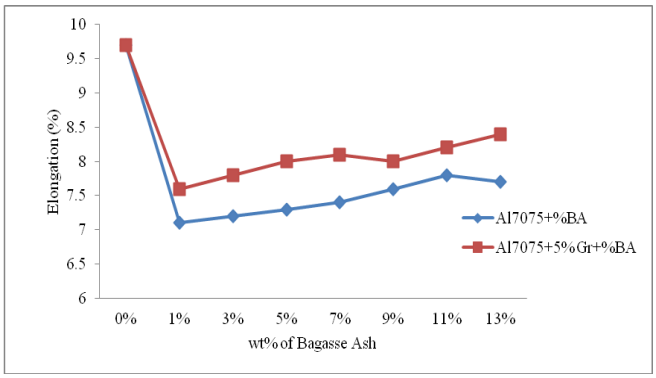


Fig. 1: Variation of ductility

B. Fractography

SEM image analysis carried out at 1500X magnification, it was found that, Al-BA composites fractured surfaces are less ductile in nature shown in figure-2 (b to h). Al-Gr-BA hybrid composites fractured surfaces are more ductile in nature shown in figure-2 (i to p). It was observed that, the Gr is mixed with BA particle in base melt which decreases the porosity at fractured surface of the hybrid composites because wettability increases, whereas in Al-BA composites are shows higher porosity. Hybrid composites gives higher ductility and less voids when compared to both composite and base metal.

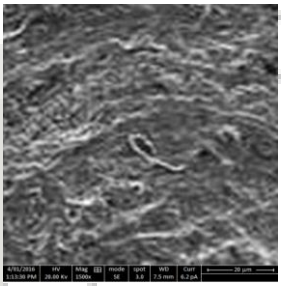


Fig. 2(a): Al+1%BA

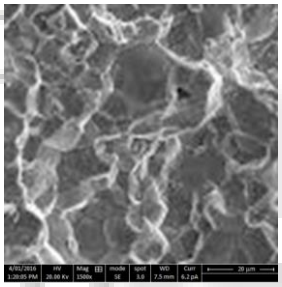


Fig. 2(b): Al+3%BA

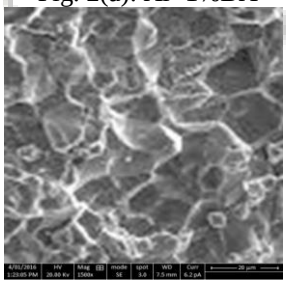


Fig. 2(c): Al+5%BA

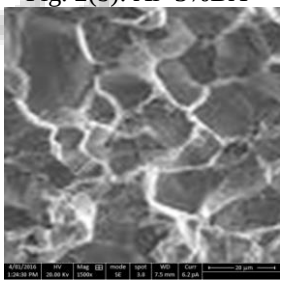


Fig. 2(d): Al+7%BA

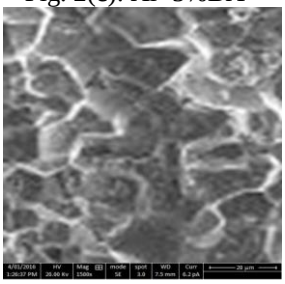


Fig. 2(e): Al+9%BA

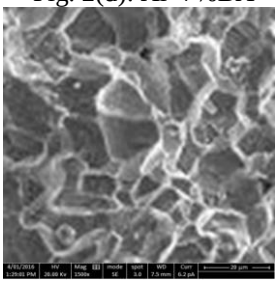


Fig. 2(f): Al+11%BA

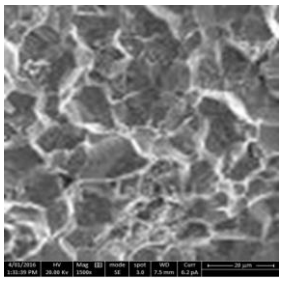


Fig. 2(g): Al+11%BA

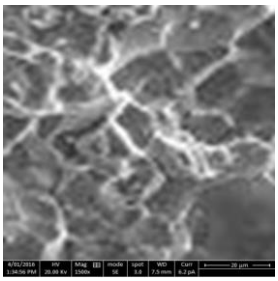


Fig. 2(h): Al+13%BA

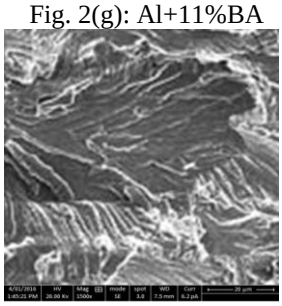


Fig. 2(i): Al+1%BA+5%Gr

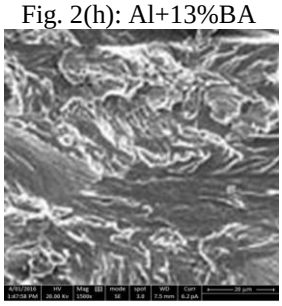


Fig. 2(j): Al+3%BA+5%Gr

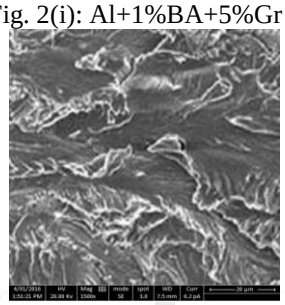


Fig. 2(k): Al+5%BA+5%Gr

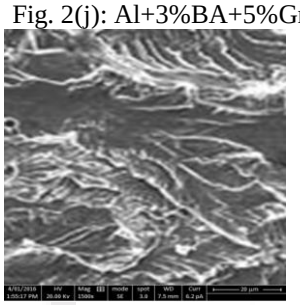


Fig. 2(l): Al+7%BA+5%Gr

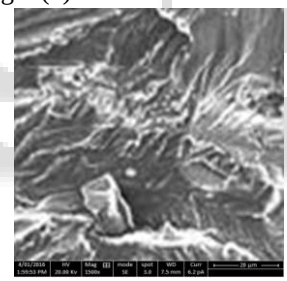


Fig. 2(m): Al+9%BA+5%Gr

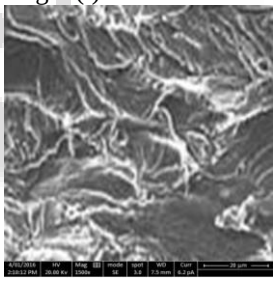
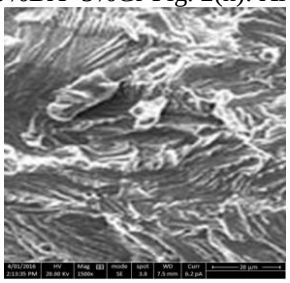


Fig. 2(n): Al+11%BA+5%Gr



2(o) Al+13%BA+5%Gr

Fig. 2: SEM of fractured surface of composites and hybrid composites

C. Discussion

The percentage elongation increased with increasing BA content in composites and hybrid composites which shows higher ductility and tensile strength of the material because wettability of melt and interfacial bonding is more by the addition of Gr particles. Fractography of SEM images clearly shows that absences of Gr shows less interfacial bonding and presence of composites have more interfacial bonding. This was achieved due to proper stirring, higher wettability and less oxidation at the time of fabrication, which give less

porous and voids. Hybrid composites has less porous, higher ductility and mechanical strength than Al-BA composites.

IV. CONCLUSIONS

Composites was processed successfully by using vortex method. The results were shows that, hybrid composites has superior percentage elongation than Al-BA composites and base alloy. Fractography results shows that of less interfacial bonding in composites and higher in hybrid composites. Hybrid composites ductility and micro-fracture strength much higher than Al-BA composites.

V. FEATURE SCOPE

Wear test, corrosion test etc. will be carried out for my further research work.

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