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Experimental Investigation on Mechanical Properties of Al 6061 Metal Matrix Composite Reinforced with Aloe Vera Powder

Ch. Hima Gireesh, K.Ramji

Abstract: ***At present manufacturers are focusing towards the use of metal matrix composite materials instead of monolithic aluminium alloys in automotive , marine and aerospace applications as they have good power to heaviness proportion, elevated firmness, wear confrontation, ease of manufacture etc. However, despite considerable improvement in the growth of metal matrix compounds, it is still required to develop metal matrix composites with cost effective eco-friendly reinforcement materials. The powder form of a Aloe vera is a light weight material and low cost, non-harmful to environment. In the present work metal matrix composites are prepared with Al6061 as matrix material and Aloe vera gunpowder as strengthening fabric. Stir casting technique have been working in the present work to prepare the specimens of proposed complex. The specimens are equipped as per A.S.T.M values and tests have been conducted to discover mechanical characterization of the proposed combined. It is found that ultimate yield strength and hardness with Al6061-AV are enhanced slightly as compared to that of pure aluminums based metal matrix composite reinforced with AV powder (Al-AV). No significant difference between Al 6061-AV and Al-AV composites in respect of density, ultimate tensile strength and wear resistance. Therefore, Al 6061-AV composite is suitable for applications where less density with high yield strength and hardness are predominantly required.***

Index Terms: ***Al6061 metal/matrix composites, aloe-vera-powder, mechanical description, stir casting***

I. INTRODUCTION

Particulate aluminum matrix composites (PAMCs) possess good strength, formability, structural efficiency etc. and hence they are extensively used to manufacture various parts of vehicles and used in parts braking mechanism of heavy vehicles like trains, trucks and cars etc. and aerospace applications etc. [1]. The reinforcement materials employed in preparing PAMCs are usually high strength ceramic particles and fly ash. The artistic strengthened aluminum network composite materials are most prevalent because of their high solidarity to-weight proportion, unrivaled tribological properties and erosion obstruction conduct.
Kalaiselvan et al. [2] and Ravi et al [3] made an endeavor to manufacture AA6061 composite strengthened with B4C particles utilizing mix throwing strategy. Mechanical portrayal was done and the rigidity and hardness have expanded through the augment in heaviness proportion of B4C particles. Gopala krishnan and Murugan [4] carried experimental study on involuntary categorization of AA6061 metal matrix compound unbreakable through titanium carbide (TiC) particulate. They revealed that the detailed power of the fabric enhanced appreciably among extra addition of T.i.C. Singh et al [5] prepared red mud reinforced aluminium alloy A6061for observing its micro hardness. They found that there is a considerable improvement in micro hardness with increment of percentage of red mud. Bhushan and Kumar [6] fabricated Al 7075 composite reinforced with SiC particles using stir casting method at different stirring speeds. They observed that present is an enhance in tensile force and stiffness through the boost of S.i.C reinforcement. Currently, many researchers attempted on use of industry waste materials as inexpensive reinforcement particles in AMCs to address the cost barrier. It is observed from the literature that a strong waste result of coal-terminated warm power plants called fly cinder (FA) has been joined as support material forAMCs throughout the previous couple of decades to lessen their weight, fabricating cost and improving chosen properties. As the contaminations, for example, As, Se, Cd, Cr, Ni, Sb, Pb, Sn, Zn, and B are enhanced in coal ignition results, there may negatively affect FA usage because of natural confinements[7]. Rao et al [8] prepared Al 6061 composites reinforced with varying amounts of flyash and conducted experimental investigation to know its mechanical characterization and machining behavior. The outcome of their experimental study showed that the increased fly ash content in the composite of Al6061 increases the hardness of the composite with the increment of fly fiery remains content. Dinaharan et al [9] announced the portrayal of Al6061 composites fortified with fly fiery remains particles blended utilizing contact mix handling. Their investigation uncovered that the fly fiery remains particles were disseminated homogeneously in the composite independent of the volume portion and upgraded the small scale hardness of the composite . The fly ash reinforced AMCs are not only to overcome the cost barrier, they are successfully applicable to aerospace, automobile and other structural applications. In recent times the researchers focused towards the utilization of agro subsidiary fiery debris as support materials in AMCs with the end goal of supplementing fortification to either SiC or Al2O3 [10].
Considered the mechanical qualities of agro subordinates, for example, breadfruit seed body fiery remains, rice husk, bamboo leaf, coconut shell, sugarcane bagasse and so forth. as reinforcing material in AMCs.

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***** Correspondence Author (s)
Ch. Hima Gireesh, Asst. Professor, Dept. of Mechanical Engineering, GVP School of Engineering, Gayathri Vidya Parishad College for Degree & P.G. Courses, Visakhapatnam, A. P, India.
K.Ramji, Vice-chancellor, Dr. B.R. Ambedkar University, Srikakulam, A.P, India.

Atuanya et al [11] fabricated AMCs reinforced with breadfruit seed hull ash particulates (BFSHAp) through two fold mix throwing procedure and they reasoned that the expansion of BFSHAp as fortification in composite aluminum grid can be utilized for expanding wear obstruction of the composite. Aku et al [12] created metal framework composites of aluminum strengthened with coconut shell fiery debris (CSA) and they recognized that the rate increment CSA can prompt the generation of minimal effort aluminum composites with improved hardness. Deshmukh et al [13] contemplated the mechanical properties of AMCs fortified with rice husk slag (RHA) and metallurgical evaluation silica with fluctuating level of Mg. They watched the improvement in mechanical properties of the composite delivered by utilizing RHA in contrast with metallurgical evaluation silica. Usman et al [14] analyzed the mechanical properties of sugarcane bagasse fiery remains (SBA) fortified AMCs and they found that the mechanical properties are inside the scope of properties of materials utilized in the creation of different car parts. Recently attempts made on using Orange peel ash particulates as reinforcement for Al–Si–Mg alloy to observe the mechanical characterization of the composite [15]. Prasanna et al [16] prepared Al 6061 composite samples which are reinforced with SiC and Neem leaf ash (NLA) particles using stir casting. They found to facilitate the stiffness of the sample among SiC moreover NLA particles increases significantly compared toward that with Al 6061 complex unbreakable among SiC as well as fly residue particles.

However, sugarcane bagasse/coconut shell/bamboo leaf/rice husk etc are suitable as reinforcement material for AMCs, there might be the creation of air pollutant gases during the conversion of these agricultural materials into the respective ashes, thereby posing risk to human and ecological health. In this background it is essential to recognize environment gracious strengthening material on behalf of creating AMCs. This might have been the motivation for the present work on examining the suitability of aloe vera powder as novel underpinning textile for preparing AMCs. Aloe/Vera is a unique wonder plant by pertaining the healing, moisturizing and luscious qualities [17] initially it was harvested in tropical Africa, now the popularity of its benefits made to cultivate in warm climatic areas like Mexico, China, Australia, ,coastal areas of Latin American countries and south India. In India, the normal yield for naturally developed aloe is around 12 tons for every hectare. The manor of aloe vera does not require much water and it requires 150ml of water month to month for yield of good quality leaf weighing roughly 1 kg. [18]. The aloe vera essentially contains calcium, magnesium, sodium, potassium, phosphorous, iron, manganese, copper and zinc [19]. It is extremely short stemmed succulent plant developing to 80 to 100 cm tall, spreading by counterbalances and root grows. The contact plot for aloe vera leaves is 96.89° [20] and henceforth it has extensive wettability. Since aloe vera is to a great extent accessible, effectively cultivable, less defenseless to decay in long haul stockpiling, simpler to deal with, less thick eco-accommodating material with significant wettability, it is considered as support material for getting ready AMC in this work. A near report between aloe vera (AV) powder fortified with Al 6061 lattice composite and AV powder strengthened unadulterated aluminum network composite is additionally displayed in this paper. The preparation and mechanical characterization of the proposed composite through experimentation are discussed in the subsequent sections.

II. MATERIALS AND METHOD

Materials

The base material to carry out the present investigation is Al 6061in the form of slabs. AV powderis considered as reinforcement material for preparing the proposed composite. Whilemakingpowder, fresh leaves of aloe vera were taken and chopped as slices of thickness 5mm anddried up at 100 ^{0}Cfor a period of 8 hoursto remove complete moisture content present in it, the outcome is then grounded into a powder.

Method

Mix throwing technique has been utilized in setting up the proposed composite. The preheated AV powder of 10 wt % of base metal was acquainted step by step in with the liquid Al6061 which is at about 720°C. Before mixing little measure of magnesium powder (3 wt %) was added to improve the wettability of AV powder. At that point the liquid metal was mixed at a steady speed of 300 rpm for 5 minutes to accomplish homogeneity of the blend of network material and AV powder. The dissolve was filled the mellow incredible the blend was kept in the pot about a large portion of a moment in static condition and after that it was poured and cast in a gentle steel pass on. The four examples of AMCs fortified with AV powder of same measurements are gotten. The examples are prepared for testing to consider their mechanical characterization.

III. MEASUREMENT OF MECHANICAL PROPERTIES

In arrange to discover mechanical classification of the proposed AMC, various tests have been carried on the specimens.

Density measurement

To determine the density of the composite, Archimedes principle has been utilized. The specimen of the composite was initially consider in air also then in distilled water. The subsequent phrase to decide the thickness of the composite.

$$\rho = \rho_w \left(\frac{W_1}{W_1 + w - W_2} \right)$$

Whereρ = density of the composite.

ρ_w= density of water

W_1=weight of the composite specimen when hung air

w= weight of the partly immersed wire to hold the composite specimen

w_2= weight of the composite specimen in water along with the holding wire

The value of density obtained for the composite is 2.20 g/cc.

Tensile test

The tensile power, yield force as well as elastic modulus of the examination specimens were found by conducting the tensile test. In the current work, specimens of the compound were prepared as per.

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ASTM standards and by use worldwide testing mechanism the tensile test was carried out. The tensile strength and elastic modulus be determined by using the stress-strain graph which was plotted while doing the experiment on universal testing machine. The Figure-1 demonstrates the stress-strain bend for the proposedcomposite. The experimental values of ultimate tensile power also yield power of the proposed compound were 81 Mpa and 64 Mpa respectively.

Hardness test

The Brinell hardness testing machine having 5mm diameter indenter was used in hardness calculation of the proposed composite.In the process of hardness testing the indenter was pressed for some time and it was penetrated into the testing material because of applying a specific load.The penetration of the indenter left the indentation on a material and it was measured by low powered microscope. In this experimentation a weight of 500/kgf was practical for 30 seconds. The average diameter of the indentation calculated by taking the indentations at different locations on the proposed composite material is 3.9 mm.The Brinell hardness was measured by division of total applied load with the surface area of indentation. The measured Brinell Hardness Number (BHN) for the proposed composite material is 36.

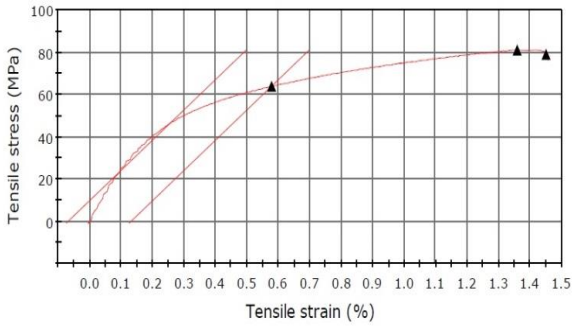

Figure 1.Stress-strain curve for Al6061-AV composite.

Impact strength test

The impact force is an capability of a fabric to absorb the energy before getting the fracture while doing the impact strength test. The impactstrength of a proposed composite material was tested by using the Izod test. In this test the Izod specimen was equipped as per the A.S.T.M values. The test is approved out on a pendulum kind testing mechanism which consists a example fixed at one end like cantilever beam. The specimen is 75 mm in distance end to end in addition to a cross part of 10 x 10 mm^2 and having a 2 mm deep notch with an inclination of 45^{0}.The obtained impact strength of a composite material is 1.85 J/mm^2.

Wear test

A wear is a tribological property of a material .When two surfaces of a material sliding or rolling each other under a specific load the material will remove from both the materials, this removal of material is called as wear. This is an undesirable material property because of a material wastage. To reduce this wastage, composite materials were prepared to increase the wear resistance. In this present work the sport of proposed compound fabric is found by conducting wear test on pin-on-disc wear tester. The standard specimens in favor of conducting wear test by using machining operations. The standard specifications of wear test specimen are 35 mm in duration moreover 6 mm in diameter. This specimen is rotating on a disc of a pin-on-disc apparatus which was finished of EN 31 Steel containing 60 HRC hardness. The two parameters resistance force as well as wear was calculated with assist of a electronic sensors. These 2 are calculated among the help of input parameters load also sliding distance.[21]. The wear test was carried on the composite specimen at20N nominal load and maintaining the constant sliding speed 1250 rpm at room temperature without lubrication. The mass of the specimen before and after the experimentation wascomputed by using photoelectric balance. The wear for thecomposite specimen was found as 85 microns.

Microscopic examination

The micro structure of a proposed composite material (Al6061-AV) was examined by using Scanning Electron Microscope (SEM).The microstructure of Al 6061-AV is depicted in the Figure2.The examining of Micro structure reveals that a proper bond was formed between matrix material and aloe vera powder particles

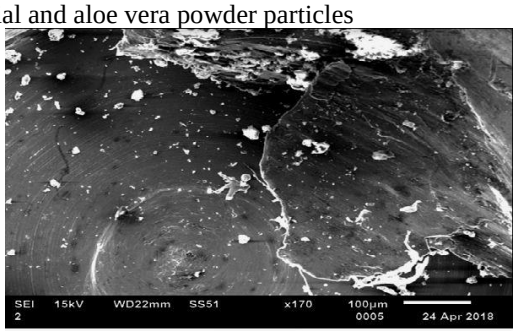

Figure 2.Microstructure of Al 6061-AV composite.

IV. RESULTS AND DISCUSSION

The mechanical belongings of a complex Al6061-AV and a composite with pure aluminium as matrix material and aloe vera powder as reinforcement were shown in Table 1.The mechanical properties of Al-AV were investigated by Gireesh et.al [22].

Table 1.Mechanical properties of Al-AV and Al6061-AV.

Material	Density (g/cc)	Ultimate tensile strength (MPa)	Ultimate yield strength (MPa)	Impact strength (J/mm^2)	Hardness (BHN)
Al-AV	2.21	120	63	1.80	34
Al6061-AV	2.20	81	64	1.85	36

V. CONCLUSION

The significant conclusions of the studies on composite materials Al6061-AV powder and Al-AV powder.

- The preparation of Al6061- 10 wt % of AV is successfully made by Stir casting method.
- The density of the composite Al6061-AV (2.20 g/cc) same as Al-AV (2.21 g/cc) and less than Al6061(2.7 g/cc).

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- The microstructural studies of prepared composite reveals theuniform distribution of Aloe vera particles with base material.
- The hardness of the composite is found to be 36 BHN whereas the hardness of the Al-AV is 34 BHN.
- In the comparison of Al-AV with Al6061-AV the tensile strength is decreased but slight increase in yield strength.
- The impact strength of composite is having better value when compared with Al-AV.
- From the studies in overall it can be concluded that the Al6061-AV composite is exhibit good mechanical properties and it is suitable for the applications where requires low density, high yield strength, high hardness and high impact strength.

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