Fabrication of the Hybrid Composite Material Aluminium 6063/Magnesium AZ31B with TiO2/B4C/Glass Powder by the Process of Friction Stir Additive Manufacturing

Anil Kumar Mishra, Sanjay Kumar, Rakesh Kumar Singh and Ankit Sharma

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Anil Kumar Mishra*, Sanjay Kumar*, Rakesh Kumar Singh*, Ankit Sharma*

*(Department of Mechanical Engineering, Noida Institute of Technology Greater Noida, U.P, Greater Noida Pin-201306, India)

*Corresponding author email:skumarrk1@gmail.com

Abstract

Additive manufacturing (AM) methods are probably the most widely used assembly strategy. There are several AM processes companies are using today, but friction stir additive manufacturing (FSAM) is narrowing the gap between what companies are citing and what can be achieved by other methods. It's a slowly growing process. In Contact Mixture AM, he joins one layer to another by erosion mix welding, creating a multifaceted fragment. This is another AM strategy that uses abrasive mixed treatments and erosive mixed welding. With this technology, we have obtained unrivalled features such as no inner holes, no sink marks, and high surface accuracy. We intend to use the microstructure and mechanical properties of the shards supplied during regrind additive manufacturing to understand the key criteria and highlights of regrind additive manufacturing. Authored by some logic analysts and developers, this part provides an overview of his work with FSAM and the areas that led to his improvement of FSAM as a notorious additive manufacturing process. So far, our conversations about FSAM have been based mainly on mesh mixed welding and his FSW of various materials, and the overall method that FSAM is based on.

Keywords: - Friction Stir Additive Manufacturing, Porosity, Strength, Reinforcement, Hybrid Metal Matrix Composite, Metal Matrix Composite, Matrix Material.

Introduction:

Friction Stir Additive Manufacturing (FSAM), a new multidimensional structure is generated by inserting a non-consumable mechanical assembly into the covering sheets or plates to be welded and investigating along the joint line. In terms of setting time, friction stir additive manufacturing represents a change from scouring blend welding. Along these lines, a strong condition is reached for the intersection [1]. Shear deformation will produce heat and aid in the workpiece of the material by heating up the exposed area between the tool and the workpiece as well as similarly with fictile deformation. In FSAM, heat is produced between the work item and the apparatus, which needs to harden. A lot of control is practiced over the microstructure because of this brand name, causing better properties. As per this procedure, the last structure height depends on the profundity of each coat and the amount of collecting coats. What's more, changing the estimations can bring about different shapes and sizes. In FSAM, the overall energy of microstructural progression depends upon the warm cycle, and strain rate which is obliged by the cycle factors that integrate rotational rate, cross speed, mechanical assembly math and production power [2]. In 2002, White put in and safeguarded Friction Stir Additive Manufacturing [3], and a near procedure was additionally introduced by Thomas et al. in 2005 [4]. In 2006, Airbus showed its capacity to deliver its development at a quicker degree by lessening critical extras by using Friction Stir Additive Manufacturing [5]. The course of Friction Stir Additive Manufacturing is a quickly creating process for creating added materials via interfacing constituent coatings upon coatings in bearing of fostering a 3- Dimensional thing after cutting edge data has been assembled [6]. The previously mentioned manages the norm of contact blend welding. In any case, FSAM differs from FSW as the joining of one layer after one more is joined by warming and once again sintering [7]. For the FSAM strategy, it is ideal to consider it a type of contact blend lap welding. Added substance Friction Stir Processing (AFSP) is characterized as the option of different materials to base metal by erosion mix handling. The distinction between AFSP and FSAM is both that AFSP is a confined grain refinement strategy, and furthermore that it doesn't make heat-affected zones (HAZ).

AM incorporates creating of 3D parts, generally speaking, of one layer Because of their movement on the strong state, scouring-based added substance creating additionally called Friction Based Additive Manufacturing (FBAM) measures it has specific inclinations over normal AM procedures, two or three which are non-participation of porosity/flees in the finished segment, a fair harmony of mechanical properties, and low level of extras over the other layer extension of substance clearly by a PC upheld arranged example. Considering their capacity to use the strong state, friction-based added substance fabricating (FBAM), enjoys specific upper hands over other standard AM procedures, remembering no porosity or buildup for the completed item, fair of mechanical properties, and low degrees of byproduct. Am permits things that are environment well disposed. The upside of AM contrasted with other traditional gathering techniques is that it permits makers to incorporate lean creation rehearses into their cycles, which don't make squander. A lone article can be cemented from many secluded parts because of AM's capacity to perform complex estimations. Besides, the topologically better plans that AM is good for recognizing could extend a thing's handiness, thusly decreasing the proportion of energy, Fidel, or trademark resources required for its movement [7]. In examination with other customary methods, the produced thing enjoys colossal benefits, including less material use and less power utilization. The cycle is good for making a superior standard thing having astonishing layered precision and substance properties [8], In this task, our work explicitly manages FSAM and demonstrates that the part delivered utilizing FSAM has altogether preferable properties over the part fabricated by other ordinary strategies [9]. An advantage of working on FSAM is that it has no unfavourable results on the climate, for example, it delivers no destructive gases, so it is free from any potential harm process for people, creatures, and nature the same. The fundamental point of the investigation is to show that separated from being climate amicable the interaction likewise delivers a material with cutting-edge mechanical and microstructural properties. Presently the focuses that are referenced beneath will put some light on why the undertaking is significant: - This venture will help in surveying the benefits and faults of parts created by FSAM - As FSAM offers eco-accommodating, quick, adaptable, and exact arrangements, businesses like the clinical, aviation, carrier, and transport will utilize them assuming they produce wanted results. - An all the more harmless to the ecosystem producing method will be accomplished as contrasted and other customary cycles.

Metal Matrix Composite:

Aluminium:

Aluminium is a chemical element. Its symbol is Al Its atomic number is 13. Aluminium has a lower number. Higher density than other materials. the density of Aluminum is about one-third that of steel. The Aluminium matrix material (MM), has a thickness of 3 mm. As shown in Table No.01 Al6063 has good mechanical properties. Table 02 shows the chemical composition of Al6063.

Fig.:01 Aluminium Plate 6063

Magnesium:

A wrought magnesium alloy with excellent strength and flexibility at room temperature in addition to corrosion resistance and weldability is called AZ31B. A wide range of applications for AZ31B includes speaker cones, concrete tools, cell phone and laptop cases, and aircraft fuselages. At high temperatures, AZ31B can be performed to produce a wide range of complex automotive parts.

Table.:01 Chemical Composition of Magnesium AZ31B

Weight %	Al	Zn	Mn	Si	Cu	Ca	Fe	Ni	Others	Mg
Magnesium AZ31B	2.5 - 3.5	0.7 - 1.3	0.2 min	0.05 max	0.05 max	0.04 max	0.005 max	0.005 max	0.30 max total	bal

Table.:2 Mechanical Properties of the Magnesium AZ31B

Material	Condition	Thickness	Tensile Strength	Yield Strength	Elongation in 4D(%)
Magnesium Alloy AZ31B Sheet	Plate	2.00 - 3.00	34	18	8

Fig.:02 Magnesium AZ31B after cutting the Grove

Reinforcement: -

The reinforcement is selected on the behalf of their properties. TiO_2 and B_4C and glass powder is used in this reinforcement in the nano form.

Fig.:03 TiO_2

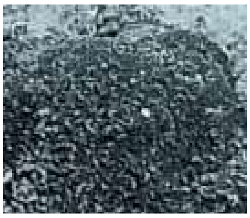

Fig.: 04 Glass Powder

Fig.:05 B_4C

Tools:

The hexagonal tool was selected for this research. Tool moulds are manufactured by HSS Road. The rod measures 100mm long and 16mm in diameter. After completion, a machine tool is manufactured using a grinding machine. The illustration shows the tool profile.

Fig.:06 (a), (b), (c) Hexagonal Tool Profile

Fixer:

A complete fixture is designed for holding the materials and makingthe experiment stable.
The main reason why we performed through bolting and not clamping is that in clamping there is shearing.

Fig.:07 Fixer

Experimental Procedure:

To perform the FSAM the components are fixed into the fixture and layer-by-layer joining is performed. In this method, a tool attached with a pin and shoulder is inserted inthe uppermost surface of the stack, which moves in a forward direction creating heat through friction and resulting in the joining of the layer. The length of the tool used shouldbe longer than the build layer in order to achieve the joining of the two-stacked layer at the same time.

Process parameter selection: -

These parameters were followed during the experimental preformation.

Table.: 03 Processes Parameter During Experimentation

Serial No	Rotational Speed	Feed	Tool Tilt Angle	Traverse Speed
1	1000, 1400 RPM	2.5 mm/Min	0^0	1625 mm/Min
2	1400	2.5 mm/Min	1^0	1625 mm/Min

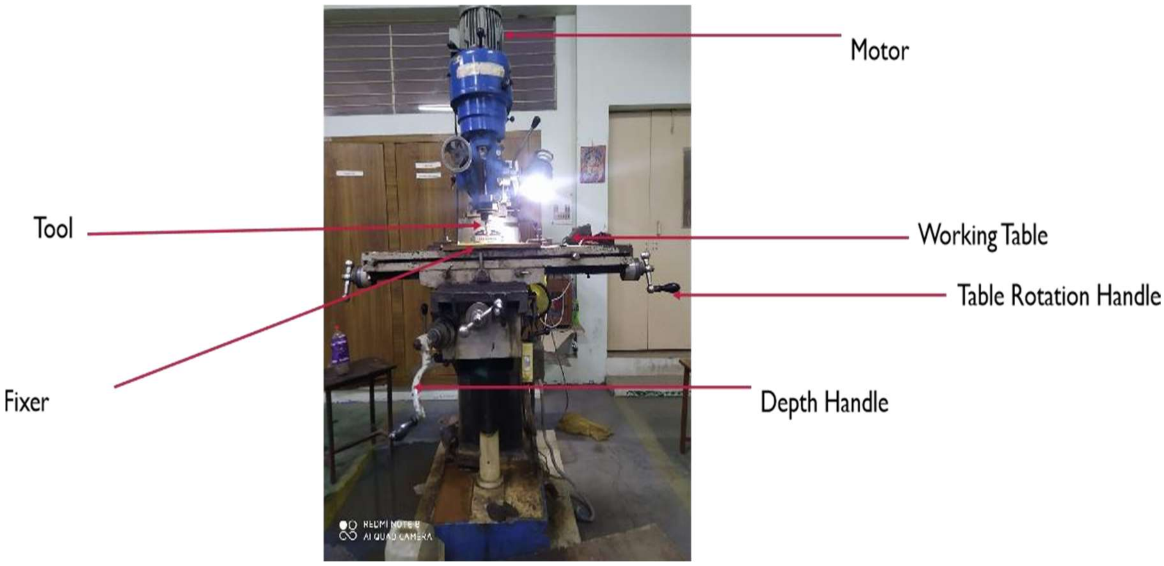

Fig.:08 Verticle Milling Machine

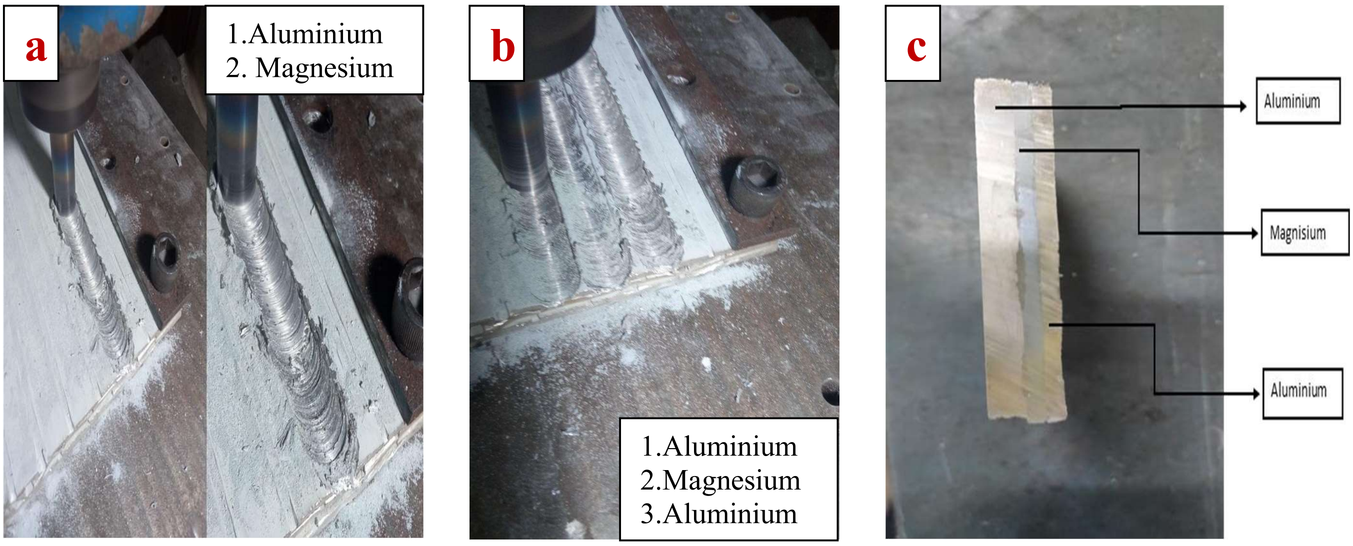

Fig.:09 (a) Two-layer Joining (b) Three-Layer Joining (c) Layer by Layer

Characterization of the Mechanical Properties:

After completing this process, the sample is converted into a special dimension for testing. And calculate the mechanical properties of the specimen.

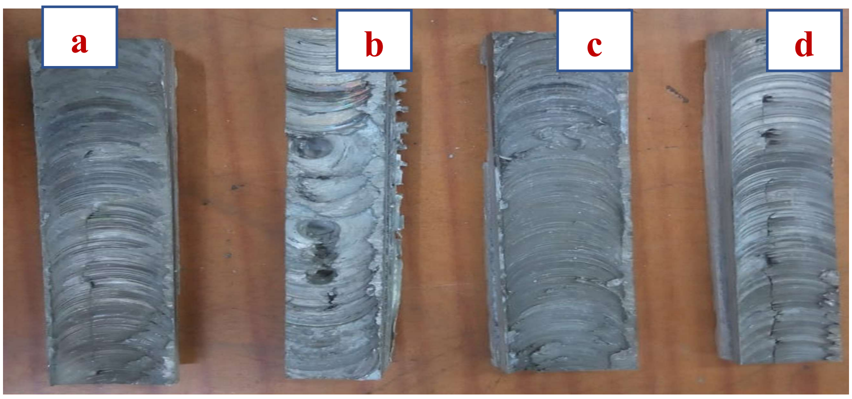

Fig.: 10 (a, b, c, d) Sample of the composite

Hardness:

The hardness of the contact mix welding test was assessed with the assistance of a miniaturespace strategy. They got (Rockwell) for covered (AA6063), and Magnesium (AZ131). The most extreme hardness an incentive for covered example at the point of interaction will be 375 and the normal hardness an incentive for covered example of point of interaction locale 1 is 317.5 and the connection point district 2 is 312.5. the ordinary hardness esteem at mix area of covered example is 218. The worth of hardnessresult shows the improvement in hardness estimation because of principally two explanation the main explanation is a refinement of extraordinary grain which can saw atinterface area of mix zone and the second is the advancement of various kinds of the intermetallic compound at the joint of point of interaction locale and mix district. The worth of hardness at interface joint is higher than the hardness at mix district (roughly 28 % will more than the mix locale). The got worth of miniature hardness worth will improve the (Al-Mg) material.

Table.: 04 Hardness Result of the Composite Material

Serial Number	Rockwell	Brinell
1	55 (HRB/100/30)	52 (BHN)
2	57 (HRB/100/30)	59 (BHN)
3	63 (HRB/100/30)	65 (BHN)
4	69 (HRB/100/30)	71 (BHN)

Tensile Test:

One of the key features of tensile testing involves accurate control over test speed, precise measurement of extension, the amount of force required to hold the extension and the use of appropriate grips and fixtures.

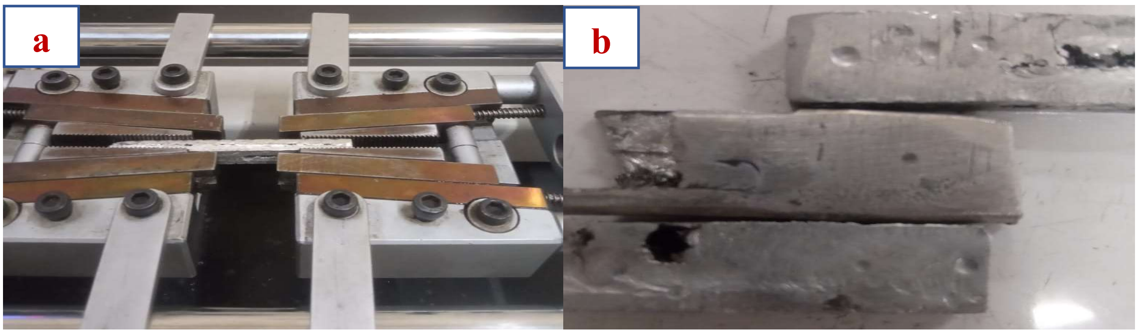

Fig.: 11 (a) Tensile Specimen with Jaw in Tensiometer (b) Tensile test specimens after test

Table.:04 Tensile Test Reading

Serial Number	Sample Number	Tensile Strength (MPA)
1	1	147.9
2	2	164.7
3	3	176.2
4	4	183.6

Conclusion:

After fabricating the composite material, find the same conclusion which is given below

- The tensile strength 6063/Magnesium AZ31B with TiO2/B4C/Glass Powder increase with the addition of the B_4C up to 4 % of the wt. (sample No.4).
- The tensile strength of the 6063/Magnesium AZ31B with TiO2/B4C/Glass Powder HMMC shows a maximum value of 183.6MPa.
- The increment in tensile strength is 147.9 to 183.6 which is 24.15 % of Sample Number 01.
- Brinell hardness increased up to 71 BHN, an increment of 36.53 % when compared with Sample Number 01 for as-cast conditions respectively.
- Rockwell Hardness is increased up to 69 BHN which is compared the sample number 01. The hardness increase is 25.41 % from sample number 01.

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