JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

INVESTIGATION ON EFFECT OF WELD PARAMETERS ON MECHANICAL PROPERTIES OF ALUMINIUM 7075 HIBRID COMPOSITE BY FRICTION STIR WELDING

Vijaya vardhana C [1,a)], Vidyasagar H N [2,b)], Shivananda H K [2],Ramesha D K[2]

[1] *Department of Mechanical Engineering, Dayananda Sagar Academy of Technology and Management, Bangalore 560082, India*
[2]*Department of Mechanical Engineering, University Visvesvaraya College of Engineering, Bangalore 560001, India*

[a)] vijayavardhanac@yahoo.com
[b)] hnv_sagar@hotmail.com

Abstract ---In this present research work an effort is made to investigate the mechanical properties of friction stir welded hybrid aluminum 7075 metal matrix composites. The aluminium 7075 matrix is reinforced with boron carbide and E-glass short fibers. Stir casting method is employed for fabrication of hybrid aluminium metal matrix composite. Reinforcements are added in weight percentage basis. Casted sample is further welded by using friction stir welding method. welding process is carried out with the weld parameters such as weld speed, weld tool feed and weld tool pin profile. Welded samples are machined according to ASTM standards in sophisticated Wire EDM. Mechanical properties of welded samples with different weld parameters are compared with sample without weld.

Keywords –*AL7075, stir casting, E-glass, boron carbide, FSW*

1. INTRODUCTION

In the current world of materials and manufacturing, the least expensive and high performance materials are what people are looking for in place of old, bulky materials. This requirement paves path for researchers to develop composites. This is because the composites have improved mechanical properties compared to the base materials alone[1]. At Present metal matrix composite materials offer better performance as light weight substitutes for range of applications starting with sports to areas like marine industries, aerospace industries as well as automobile industries[2]. Aluminium metal matrix composites fulfills the majority of requirement for light weight and high strength materials for the industrial applications[3]

Current era of industrialization is working on light weight alloys for most of the applications which necessitates innovative ideas in joining processes like welding technologies, which are required to reduce the additional weight of the joined components and to improve quality of components of the weld structures and thereby to increase the mechanical properties of weld joint. Friction stir welding is one the latest welding technology which can be employed for joining of metals, alloys and composites which are mostly non-weldable. aluminium 7075 MMC falls into the category of non-weldable by most of the convenstional welding processes, which necessitates the use of FSW process for the welding of AL7075 MMC's.

The process of Friction stir welding was developed in 1991 [4]. This process involves solid state joining of two materials which are either similar or dissimilar. In this process the material at the weld center region is deformed plastically by the stirring effect of tool. Heat required for the plastic deformation is produced by a tool rotation. The tool used is non-consumable type[5]. Microstructures and properties that are developed by the Friction stir welding process are different from conventional welding processes [6]. Similar to other conventional welding processes, rotating effect of tool during the process of welding generates heat which creates heat-affected zone (HAZ) in the exterior locations of the weld. The zone Next to the center of weld where turning tool introduces deformation into the heated material is called thermo-mechanically affected zone (TMAZ). The middle of the weld region is called the nugget zone. Due to the stirring effect of tool pin in the joining location of two materials, at the center region there will be dynamic recrystallization of severely damaged grain structure. This effect forms fine and equiaxed grains at the nugget region of the weld[7-8]. The shape of the tool approximates the nugget weld shape. Friction stir welding results in the formation of asymmetric sides on either sides of the weld, causing creation of advancing side and retracting side for the weld with respect to direction of rotation of tool. Advancing side of the weld is formed where the rotation of tool is along the direction of welding.

Table 1: Aluminium alloy 7075 Chemical composition

Chemical composition	Composition % in Al 7075
Zinc(Zn)	5.8
Magnesium (Mg)	2.6
Copper (Cu)	1.55
Ferrite (Fe)	0.5
Manganese (Mn)	0.3
Titanium (Ti)	0.2
Chromium (Cr)	0.2
Remaining aluminium (Al)	

Table 2: Chemical composition of E-glass

Chemical composition	Composition % in E-glass by weight
Silicon dioxide(SiO_2)	54.3
Calcium oxide(CaO)	17.2
Boron oxide (B2O)	8.0
Aluminium oxide(AL_2O_3)	5.2
Megnisium oxide (MgO)	0.6

2. OBJECTIVE OF THE PRESENT STUDY

Aluminium7075 alloy is reinforced with E-glass chopped fibres and boron carbide. The added reinforcements are expected to provide reasonably high Strength and Hardness. The primary objective of this project is to prepare AL7075/boron carbide/ E-Glass composites with aluminium as matrix material, E-glass &

boron carbide as reinforcements. weight percentages of reinforcements are used for preparation by using stir casting metallurgy technique. Test specimens are then welded by FSW technique for different weld parameters to evaluate the effect of these parameters on tensile and hardness properties of composite samples.

3. EXPERIMENTAL PROCEDURE

Following steps are followed to carry out experimental work

1. Preparation of composite
2. Welding of composite material
3. Testing of welded samples

3.1 preparation of composite material sample.

3.1.1 Selection of materials

Aluminium 7075 is selected as matrix material and boron carbide and short E-glass fibers are selected as reinforcement materials.

3.1.2 Fabrication of hybrid composite material by stir casting technique.

Stir casting technique is used for preparing composite material. Aluminium7075 94%,Boron carbide 2% and E-glass 4% are selected on weight basis for the study. aluminium is heated to 750^0 C[11], once alunminium reaches molten state, slag is removed from the molten aluminium which is formed on top of the molten aluminium[12]. Degassing agent is added to remove entrapped gases in the molten aluminium and magnesium is added to increase the wetttability. Preheated reinforcements (as shown in fig 3.2) are added with stirring at a speed of 300 rpm[13] and stirring is continued for about 15 minutes to ensure homogenous mixing of reinforcements as shown in the fig.3.1. Mixture is then poured to pre heated die and allowed to cool naturally.

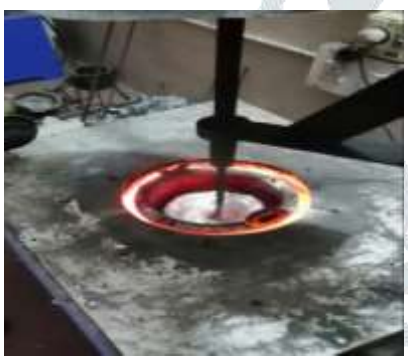

Fig 3.1: Molten state AL7075

Fig 3.2: preheated reinforcements

3.2 Welding of composite material by friction stir welding process

3.2.1 Selection of welding parameters

Weld tool pin of conical profile is selected for the study. Three rotational speed for the tool selected are 900 rpm,1100rpm and 1300rpm.Three tool feed rates of 30mm/min,40mm/min and 50mm/min are selected for study.

Figure 3.3 shows the FSW tool with conical profile pin. And figure 3.4 represents welded aluminium plate

Fig 3.3: Conical profile pin

Fig 3.4: Welded plate

3.3 Testing of samples

3.3.1 Tensile testing of samples

Welded test samples are machined to prepare test samples as per ASTM standard. Sophisticated wire electric discharge machine is used to cut the test sample for ASTM standard, Tensile test specimen are cut to ASTM E8 standard as shown in figure 3.5.

Tensile Testing of samples are carried out using sophisticated computerised universal testing machine. Figure 3.6 shows tensile tested specimen.

Fig 3.5: Tensile test specimen as per ASTM E8 standard

Fig 3.6: Tensile tested specimen

3.3.2 Hardness testing

Hardness testing samples are prepared by using wire EDM machining process and specimen are prepared for the dimension of 10mm width,50mm length and for the thickness of 6mm as shown in figure 3.7. Vickers hardness test is conducted to determine hardness of welded specimen samples. Figure 3.8 represents hardness testing equipment with specimen

Fig 3.7: Polished hardness test specimen

Fig 3.8: Sohesticated Vickers Hardness testing equipment

4. RESULTS AND DISCUSSION

Results of the tests conducted with varied parameters of friction stir welding are shown in the below graphs.

4.1 Tool rotational speed effect on tensile strength of specimen

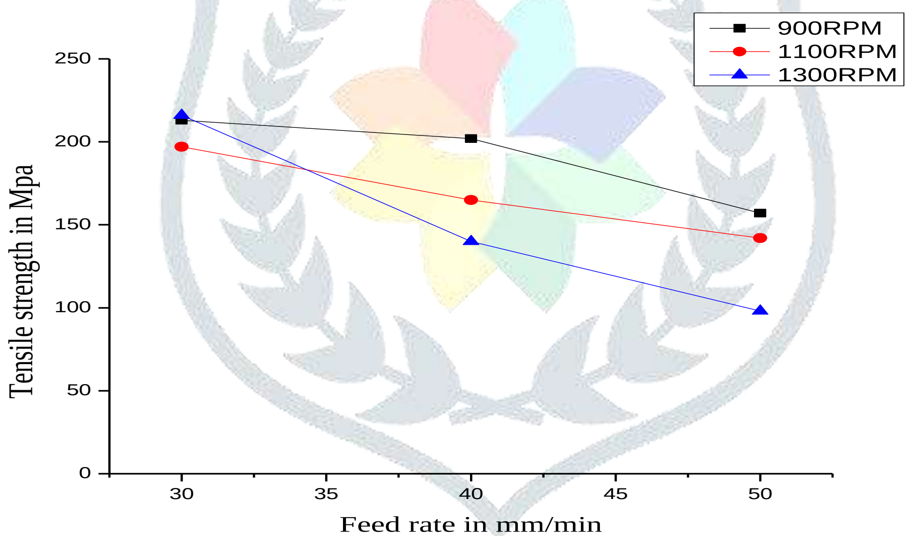

Fig 4.1: Tensile strength v/s Tool Feed rate

Fig 4.1 represents the graph of Tensile strength v/s Tool Feed rate, it is observed from the graph that Tensile strength of specimen with tool rotational speed of 900 rpm for feed rate of 30, 40 and 50 mm/min has shown decrement trend. Same trend is observed for 1100 rpm and 1300 rpm of tool rotational speed. At high speed of 1300 rpm it can be observed that with the increment in feed rate there is considerable change in tensile strength in the material.

4.2 Tool feed rate effect on tensile strength of Specimen

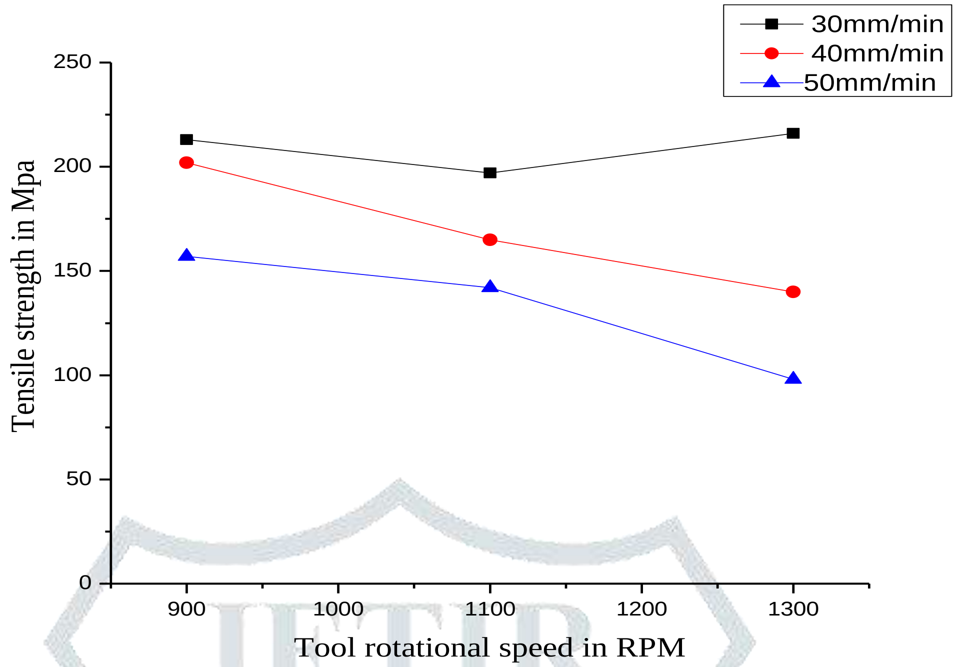

Fig 4.2: Tensile strength v/s Tool Rotational speed graph

Fig 4.2: Tensile strength v/s Tool Rotational speed graph

Figure 4.2 Represents the Tensile strength v/s Tool Rotational speed graph. For the feed rate of 30 mm/min there is increment in tensile strength of specimen for the change in incremental tool rotational speed. For the tool feed rate of 40 mm/min and 50 mm/min gradual decrement in the tensile strength for increment in tool rotational speed.

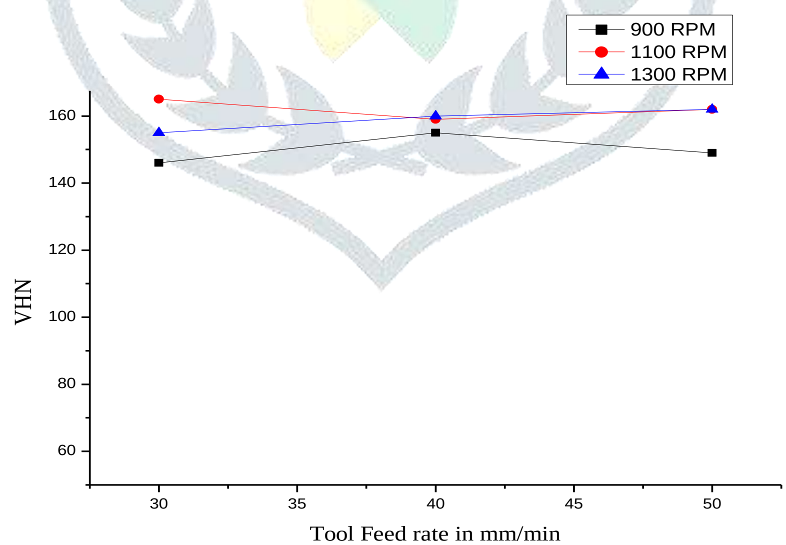

Fig 4.3: Graph of Vickers Hardness number v/s Tool Feed rate

Figure 4.3 represents the graph of VHN v/s Tool Feed rate, It is observed from the graph that hardness of the specimen with tool rotational speed of 900 rpm is less compared to 100rpm and 1300 rpm and it shows the raising trend till 40mm/min of feed rate and decreases afterwards. At high speed of 1300 rpm there increasing trend is observed for hardness. At high speed of 1100 rpm and for low feed rate of 30 mm/min highest hardness value is recorded.

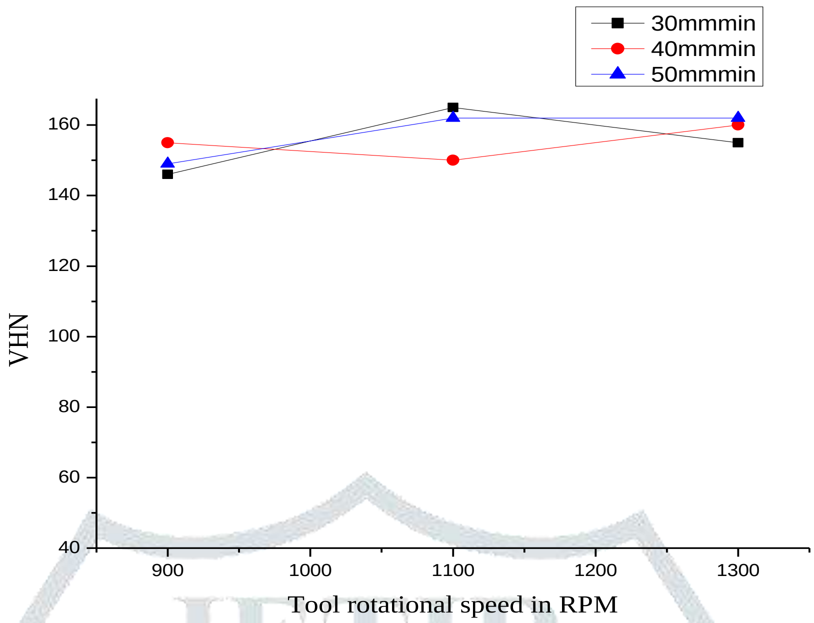

Fig 4.4: Vickers Hardness number v/s Tool Rotational speed

Fig 4.4 represents the graph of VHN v/s Tool rotational speed, It is observed from the graph that hardness of the specimen with tool feed rate of 30mm/min increases till 1100rpm tool rotational speed and decreases afterwards. with the tool feed rate of 50mm/min hardness value increases till 1100rpm and remains almost same for further increment in speed.

5.CONCLUSION

From the above conducted study the following conclusions can be drawn

1.Stir casting technology can be successfully implemented for preparation of aluminium metal matrix composites and is found to be economical fabrication technology for the preparation of composites..
2.Friction stir welding technique can be effectively used for welding of Al7075 metal matrix composite plates.
3. Variation of weld parameters affects the tensile strength of welded components
4.It is observed that there is increment in tensile strength in mmc with low tool feed rate compared to specimen without weld.
5.Maximum tensile strength is observed with the weld parameter combination of 900 rpm and 50mm/min.
6. Specimen failure section indicates strong bonding between plates at weld region.
7.Maximum hardness is obtained for the combination of low feed rate of 30mm/min and tool rotational speed of 1100rpm

6.0 REFERENCES

1. Santhosh Kumar B M, Dr. Girish D. P "**Assessment of Mechanical Properties of Aluminium 7075 based Metal Matrix Composite"** International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 5 Issue 02, February-2016
2. A. Baradeswaran, A. Elaya Perumal "**Influence of B4C on the tribological and mechanical properties of Al 7075–B4C composites**" Composites: Part B 54 (2013) 146–152, Elsevier

3. Balasubramani Subramaniam, Balaji Natarajan, Balasubramanian Kaliyaperumal, and Samson Jerold Samuel Chelladurai "**Investigation on mechanical properties of aluminium 7075 - boron carbide - coconut shell fl y ash reinforced hybrid metal matrix composites"** Overseas Foundry, Vol.15 No.6 November 2018
4. Woong-Seong Chang, S.R. Rajesh, Chang-Keun Chun and Heung-Ju Kim, J"**Microstructure and Mechanical Properties of Hybrid Laser-Friction Stir Welding between AA6061-T6 Al Alloy and AZ31 Mg Alloy**"Mater. Sci. Technol., , 27(3), 199-204.science direct, Elsevier, 2011
5. R.W. Fonda, P.S. Pao, H.N. Jones, C.R. Feng B.J. Connolly, A.J. Davenport **"Microstructure, mechanical properties, and corrosion of friction stir welded Al 5456"**Materials Science and Engineering A 519 (2009) 1–8, Elsevier
6. Yong-Jai Kwon, Ichinori Shigematsu and Naobumi Saito "**Mechanical Property Improvements in Aluminum Alloy through Grain Refinement using Friction Stir Process**"Materials Transactions, Vol. 45, No. 7 (2004) pp. 2304 to 2311, The Japan Institute of Metals
7. RajKumar.V, VenkateshKannan.M , Sadeesh.P, Arivazhagan.N, Devendranath Ramkumar.K "**Studies on effect of tool design and welding parameters on the friction stir welding of dissimilar aluminium alloys AA 5052 – AA 6061**" Procedia Engineering 75 (2014) 93 – 97 MRS Singapore - ICMAT Symposia Proceedings, Elsevier
8. VenkateshKannan.M , RajKumar.V, Sadeesh.P, Arivazhagan.N, Devendranath Ramkumar.K "**Influence of tool geometry on metallurgical and mechanical properties of friction stir welded dissimilar AA 2024 and AA5052**, Procedia Engineering 75 (2014) 93 – 97 MRS Singapore - ICMAT Symposia Proceedings, Elsevier
9. M. Ilangovan, s. Rajendra boopathy, v. Balasubramanian "**Effect of tool pin profile on microstructure and tensile properties of friction stir welded dissimilar AA 6061eAA 5086 aluminium alloy joints**"Defence Technology 11 (2015) 174e184, Elsevier
10. Sevvel P,Jaiganesh V "**Effects of axial force on the mechanical properties of AZ80A Mg alloy during friction stir welding**" (ICMPC 2016) Materials Today: Proceedings 4 (2017) 1312–1320, Elsevier.
11. Vinayashree, R. Shobha "**Study on Mechanical Property of Aluminium 6061 with E Glass Fiber Reinforced Composite**" Applied Mechanics and Materials, ISSN: 1662-7482, Vol. 877, pp 50-53, 2018
12. Mohammed Imran, A.R. Anwar Khan "**Characterization of Al-7075 metal matrix composites: a review**" j m a t e r r e s t e c h n o l . 2 0 1 9;8(3):3347–3356, Elsevier.
13. Mr. N.Basavaraj, Mr. Jagadeesh C, Mr. Kiran Raj H N, Dr. H.K. Shivanand "**Studies on Characteristics and Mechanical Behaviour of Carbon Nano Tubes & E-Glass Fibre Reinforced Al 7075 Alloy Matrix Hybrid Composites**, Paripex - Indian Journal Of Research ISSN - 2250-1991 | IF : 5.215 | IC Value : 77.65, August 2016
14. Ulhas .K. Annigeria* G.B. Veeresh Kumar "**Method of stir casting of Aluminum metal matrix Composites: A review" 5th International Conference on Materials Processing and Characterisation** (ICMPC 2016), 2214-7853 ©2017 Elsevier
15. S. Balasivanandha Prabu a, L. Karunamoorthy a, S. Kathiresan b, B. Mohanb "**Influence of stirring speed and stirring time on distribution of particles in cast metal matrix composite**" Journal of Materials Processing Technology 171 (2006) 268–273, June 2005
16. Tareg S. Ben Naser, György Krallics "**Mechanical Behavior of Multiple-forged Al 7075 Aluminum Alloy" Dept. of Materials Science and Engineering**, Budapest University of Technology, Acta Polytechnica Hungarica Vol. 11, No. 7, 2014