International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 14 (2019) pp. 3301-3303

Effect on Mechanical and Structural Properties of Rolled Aluminium Alloy 6082 by Using Friction Stir Processing with Silicon Carbide as Particulate Matter

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Abstract

Aluminium and its alloys being low density materials are sought in wide variety of applications related to automotive and aerospace sector. Taking a cue from their light weight and good strength properties, lot of work has been carried out in the development composite materials using organic and ceramic reinforcements like graphite, TiC, SiC, Al2O3, TiB2, B4C and carbon nanotubes. Further, the current trend is using these reinforcements. The idea behind developing aluminium metal matrix composites is to overcome the drawbacks of unreinforced aluminium alloys and conventional aluminium metal matrix composites in order to improve mechanical, corrosion and tribological properties. In addition to this just adding reinforcement to the matrix material doesn't contribute to overall properties but understanding of processing techniques used for synthesis of composites have significant influence on these aforementioned properties. Fabrication of composites is usually done by conventional powder metallurgy or stir casting technique. So, in order to have composites with good properties a right combination of reinforcement and processing technique is very much important.

In this study, Friction Stir Processing was employed to develop a composite layer on the surface of Aluminium Alloy(AA6082) using SiC particles(120 mesh). The effects of Rotational and Transverse speeds on the Surface Hardness of the Friction stir processed layer is investigated. By this method, it is possible to enhance the surface hardness of the Aluminium alloy to even 3 times of the original value.

Keywords: composite, friction stir processing, Alluminium alloy.

1. INTRODUCTION

Selection of material with specific properties is the key parameter in many industrial applications, especially in the aircraft and automotive industries. However, processing of such alloys with specific properties, like high strength, suffers from certain limitations in terms of cost and time of production, apart from the reduction in ductility. High strength accompanied by high ductility is possible with materials having fine and homogenous grain structures. Hence there arises a necessity to develop a processing technique that would produce a material with small grain size that satisfies the requirements of strength and ductility as well as the cost and time of production. There are new processing techniques like Friction Stir Processing (FSP), Equal Channel Angular Extrusion (ECAE), being developed for this purpose in addition to the improvements in conventional processing techniques like the Rockwell process, powder metallurgy technique [1].FSP expands the innovation of friction stir welding (FSW) developed by The Welding Institute (TWI) of United Kingdom in 1991 to develop local and surface properties at selected locations. FSP is a new and unique thermo-mechanical processing technique that alters the microstructural and mechanical properties of the material in a single pass to achieve maximum performance with low production cost in less time. In the present work, FSP is investigated as a potential processing technique for aluminium alloys because of various advantages it offers over other processes as mentioned above. FSP offers many advantages over the conventional and also the newer techniques of material processing which include being a single step process, use of simple and inexpensive tool, no expensive time consuming finishing process requirement, less processing time, use of existing and readily available machine tool technology, suitability to automation, adaptability to robot use, being energy efficient and environmental friendly [2]. Though the limitations of FSP are being reduced by intensive research and development, it still has few limitations that include rigid clamping of the work pieces, backing plate requirement, and the keyhole at the end of each pass. These above mentioned features of FSP make it a potential processing technique not only of aluminium alloys for various industrial applications especially for the FSP , but also in the fields of surface engineering, like metal-matrix composite production.

2.0 EXPERIMENTAL SETUP AND PROCEDURE:

Composition of the base material AA6082

Si	Fe	Cu	Mn	Mg	Zn	Ti	Cr	Al
0.7-1.3%	0.5%	0.1%	0.4-1%	0.6-1.2%	0.2%	0.1%	0.25%	balance

The give raw material in the form of sheet of dimension 1250*155*3mm was sheared and split into 9 pieces of dimension as shown in fig 2.

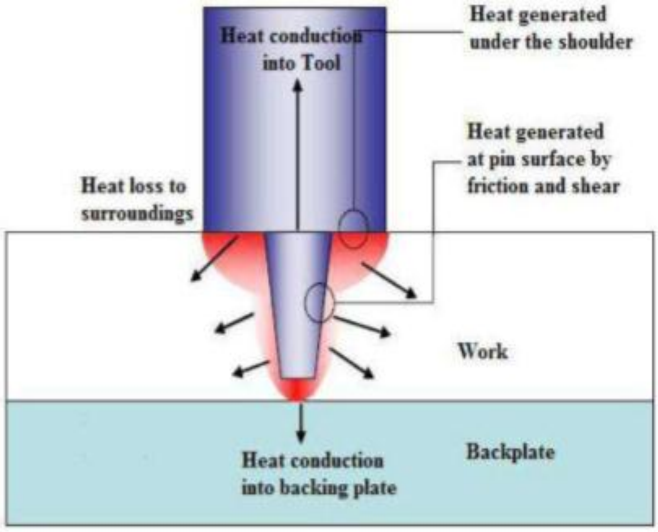

Fig 2.1: Heat flow during Friction stir welding [2].

The slot was cut on base aluminium sheet with dimensions 100*3*1.4mm. SiC was packed in slot (46.67% by volume) [6].

As per Literature Survey, the designed tool has been slightly modified to a smaller extent in order to match the process capability of the available facility.

Designed dimension of taper tool pin is:

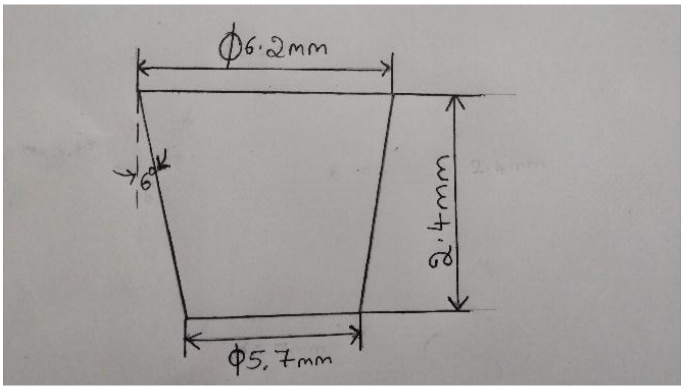

Fig 2.2: Dimension of FSP tool pin.

Fig 2.3: Photograph of FSP tool.

The modified design to a smaller extent in order to process the job on available facility [4, 10]:-

Frustum of conical pin dimensions has been changes to a moderate extent viz. longer base edge and shorter base edge are at 6.1mm×4mm and distance between them by an amount 2.3mm and taper angle is 25^{o}.

The two variable parameters like rotational speed and transverse speed has been set according to Taguchi method [7].

Following table provides information regarding the experimental parameters table 2.4.

Table 2.4: Combination of parameters for different processed joints

Specimen Number	Rotational Speed(rpm)	Transverse speed(mm/min)
1	1000	50
2	1000	100
3	1000	80
4	970	100
5	970	80
6	970	50
7	710	50
8	710	80
9	710	100

Type of device used to carry out FSP process: Universal Milling Machine

Silicon carbide are poured in the slot. Universal Milling machine is switched on. The job is mounted on the jig fixed on the table of the milling machine.

The SiC powder is poured into the perforated slot on surface of job and allow for cooling.

The job is cooled out to room temperature. In the same manner the experiment is conducted for variable rotational and transverse speed.

Stress is relieved for Friction Stir Processed jobs by using Normalizing process.

3.0 RESULTS AND DISCUSSION

Effect on rotational speed and transverse speed on surface hardness Friction Stir Processed AA6082 alloy [4, 5, 9].

As the rotational speed increases and transverse speed rate decreases from 710 to 1000rpm and 50 to 100mm/min, the surface hardness has been increased by an amount cent percent at 970rpm and transverse speed rate of 50mm/min as observed in table.

Effect of SiC on structural properties of friction stir processed aluminium AA6082 alloy [5, 8, 9].

The refinement of Grains has been moderate done when the job has been processed ay rotational speed of 970 rpm and 50 mm/min as observed on micrograph 4.2.4.

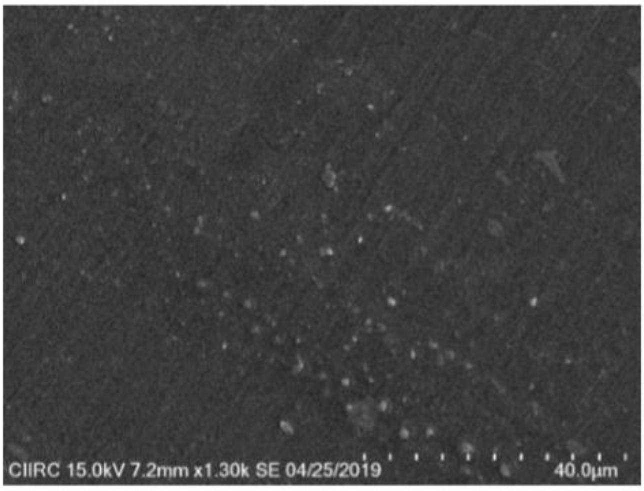

Fig no.4.2.4 SEM micrograph of joint 6 (970 rpm, 50mm/min)

4.0 CONCLUSION

To sum up the work, it can be concluded that 46.67% by volume added on AA6082 alloy processed by using Friction Stir Processing at experimental parameter of 970 rpm and 50 mm/min.

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