Microhardness of Friction Stir Processed Aluminium Alloy-6063

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Abstract— Aluminum alloy are in great demand in the field of defense, automobile, and aerospace industries. These alloys are known for its light weight, high thermal conductivity, and low coefficient of thermal expansion, high wear resistance, and high strength. Composites materials are the multi-functional materials that are having better properties. They can be utilized for the requirements of any application. In this study, Aluminum oxide were united by using Friction Stir Processing(FSP) into the commercially aluminum alloy-6063. Samples were subjected to the various tool rotating with aluminum oxide powder. Microhardness observations were carried out. The result showed that increasing rotating speed more uniform distribution of Aluminum oxide particles. The microhardness of produced alloy was improved as compared to that of base aluminum alloy.

***Keywords**:* thermal expansion, high wears resistance, high strength, FSP

I. INTRODUCTION

Friction stir processing (FSP) is a modification of friction stir welding (FSW) process. In 1991, a joining process invented by Wayne Thomas at TWI is known as the Friction stir welding process. It is a widely used technique for joining of Al alloys because; Al alloys are very poor to fusion weld. The main difference between those processes that FSP does not join materials, but can locally enhances the mechanical and tribological properties of materials like eliminates casting defects, improve ductility and strength, refine microstructure, superior wear resistance and improve fatigue and resistance to corrosion . The basic principle of FSP is similar to FSW. Friction stir processing technique is widely used as solid state processing process and a surface-engineering technology. Furthermore, the FSP technique has been utilized as surface composite fabrication on Al alloy substrate, MMC's, and cast Al alloys . A schematic of FSP is shown in Figure 1.1. The tool plays critical role during FSP, because the selection and the designing of tool material is critically important to process.

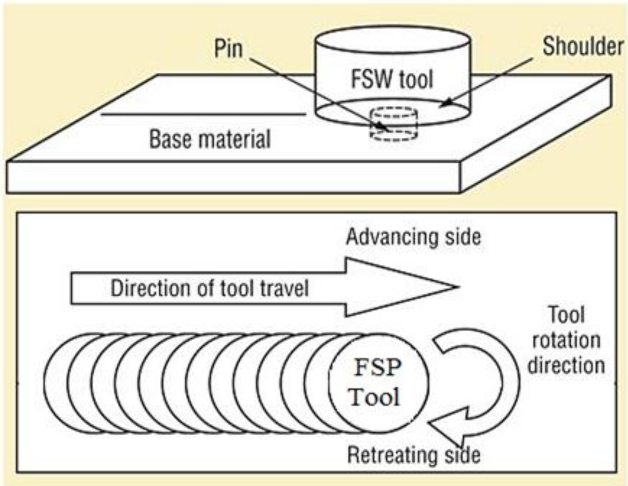


Fig. 1: Schematic of Friction stir processing

A rotating piece is defined as the tool, which designed and manufactured to plastically deforming the processed zone and produce heat due to stirring action between work piece and the tool pin. The tool consists mainly three parts such as tool pin, shoulder and the shank. The angle of the tool as compare to the vertical direction is known as tilt angle. The trailing and leading edge will be used to differentiate between the rear and front limb of the tool as the front is described as the direction of travel. Hence to enhance the mechanical and tribological properties locally, Friction stir processing shows the great route to get desired properties. Friction stir processing can be applied variably up to the depth of in the range of 0.5 to 50 mm. **Principle of FSP**

In Fiction stir processing, a non-consumable, rapidly rotating tool containing pin and shoulder. The tool pin is plunged in a work piece of material, and then moving the tool across the surface. The tool pin causes upward metal flow and a forging force provides by the shoulder. In the narrow processed zone a continual hot working action is provided by the rotating tool. As there is no liquid in narrow processed zone, it cools without solidification, with fine grain microstructure. The objective of this paper to investigate the microhardness of aluminium alloy-6063 to form metal composites by means of FSP technique.

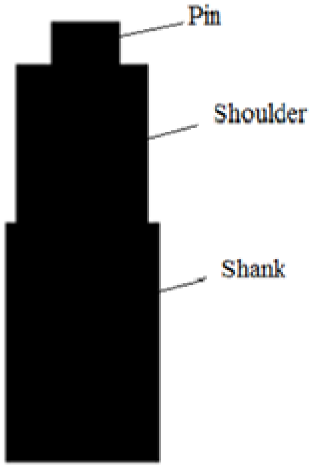
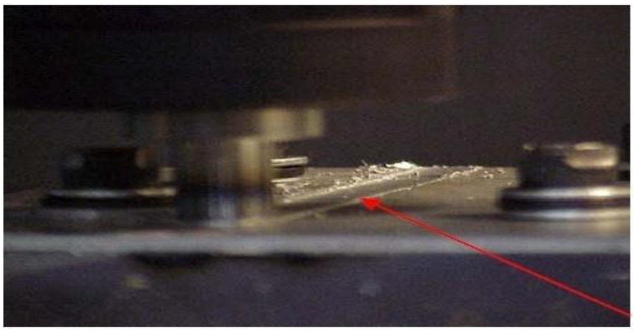


Fig. 2:Schematic illustration of FSP tool

II. EXPERIMENTAL PROCEDURE

The objective was achieved through a selection of the experimental matrix including all material selection, friction stir processing parameters, conducting a thorough analysis and performing representative mechanical tests. Based on the demand in the field of automobile, aerospace and other application we can say that the study of microhardness behaviour is almost necessary. In this present study, Al based alloy processed by FSP to enhance mechanical performance.The starting materials were plates of aluminium-6063 with a nominal composition of si-0.20-.6, iron-.35, copper-.10, mangnese-.10, zinc-.10, titanium-.10, aluminium balanced. The dimensions of work piece were 50mm×100mm×6mm. After making drilled holes in samples , the nano particles of aluminium oxide were added in the holes and surface. Fig.2 showed a schematic illustration tool designed for FSP. The tool was made up from mild steel. The tool was rotated clockwise at rotation speed of 930,1190,1480,1800 rpm. The travelling speed were constant. All FSP studies were carried out at room temperature with only a single pass. Vickers microhardness test were performed on the treated plates. Four test samples for each condition were tested.

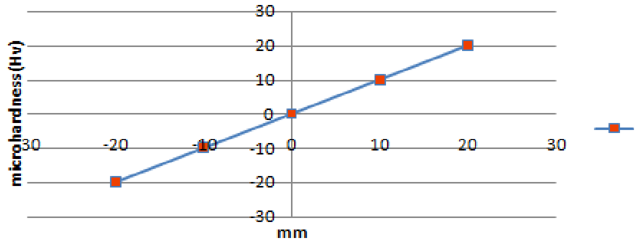


Processed zone

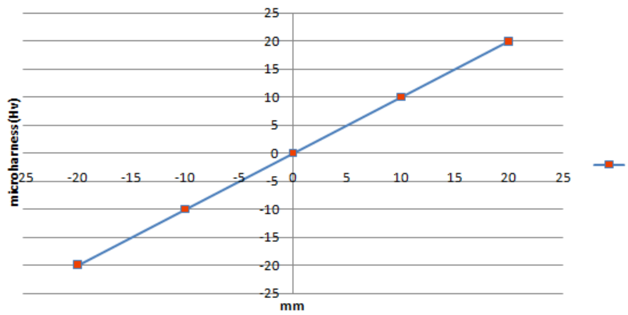
Fig. 3: Friction stir processed zone

III. RESULTS AND DISCUSSION

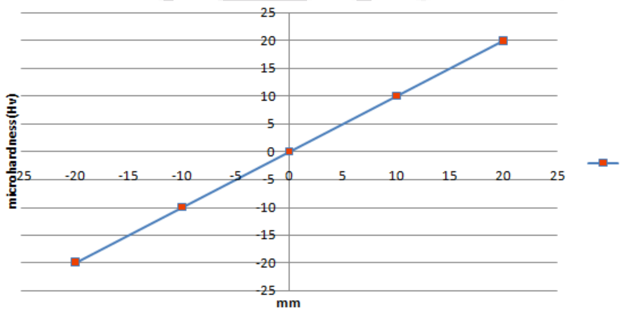
The effect of processing on the microhardness of plain and aluminium oxide particles added specimens was shown in graphs. Increased rpm caused significant increment in the microhardness values. The microhardness of processed Al-6063 has an average of 70.94. The highest microhrdness value was 73.5 and the lowest was 69.1 for processed specimens. The microhardness of plain Al has an average of 61.6. the highest value was 61.9. and lowest value was 60.4 for plain specimens. The highest hardness values were obtained from high rpm for aluminium oxide added specimens. With high rpm shoulder supplied more heat and aluminium oxide particles were disperesed well in base metal. As a result microhardness was increased with uniformly added aluminium oxide.



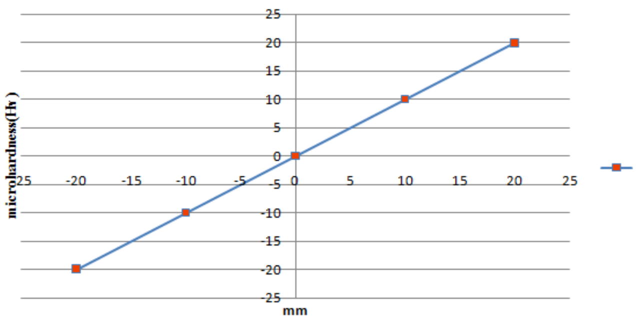
Speed=930rpm



Speed=1190rpm



Speed=1480rpm



Speed=1800rpm

IV. CONCLUSION

Inthe present study the plain Al and aluminium oxide composites were successfully united by FSP. The microhardness were evaluated obseving the reinforcement particles. The following results were obtained :

(1) It has been demonstrated that FSP was better method to modify the mehanical properties of Al-6063. FSP increased the microhardness of processed material.
(2) Increased rpm affects the reinforcing particles. A good dispersion of aluminium oxide can be obtained by ω= 1800 rpm.
(3) Good interfacial conditions between particles and base metal can be formed during this solid-state process which avoids the chemical reactions on the interface.
(4) The depth of the surface layer can be penetrated by welding parameters or probe design which could be used with pin or without pin.
(5) FSP treatments improve the formability of plain samples; hence they could be used for super plastic applications.
(6) The microhardness of the plain surface of Aluminium increased significantly with increasing rotation. The highest microhardness value was obtained 61.9Hv for the plain specimen.
(7) The microhardness of the aluminium oxide added composites increases significantly with increasing rotation speed. The highest microhardness value was obtained 73.5Hv for the processed specimen.
(8) The high microhardness of aluminium oxide composite can be attributed to the presence of reinforcement particles.
(9) With further research efforts and increased understanding, FSP could be conducted for mechanical behaviour of these composites, like fatigue and creep response and new tool design for uniform distribution of reinforcement particles into the matrix.

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