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Investigation on Mechanical Properties of AL6061 Alloy Processed by FSW

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ABSTRACT
The aim of this experiment was to improve the mechanical properties of 6061 aluminium alloys by friction stir processing (FSP), a solid-state technique for micro structural modification using the heat from a friction and stirring. The Aluminium alloy 6061 is widely used in the fabrication of lightweight structures with high strength-to-weight ratio and good corrosion resistance. Welding is main fabrication method of 6061 alloy for manufacturing various engineering components. Friction stir welding (FSW) is a recently developed solid state welding process to overcome the problems encountered in fusion welding. This process uses a non-consumable tool to generate frictional heat on the abutting surfaces. The welding parameters, such as tool pin profile, rotational speed, welding speed and axial force, play major role in determining the micro structure and corrosion resistance of welded joint. In this work a central composite design with two different speeds, traverse speeds and Four tools has been used to minimize the experimental conditions.

Keyword: *Friction Stir Processing, Shoulder Diameter, Pin Profile, Rotational Speed and Traverse Speed.*

INTRODUCTION
Friction stir processing (FSP) was developed based on the principles of friction stir welding (FSW) which was developed and patented by The Welding Institute Ltd, Cambridge, UK in 1991. FSP is a solid-state welding, micro structural modification technique using a frictional heat and stirring action, has recently attracted attention for making aluminum alloys with an excellent specific strength, and its studies have been actively performed.

Friction Stir processing is a special technique to improve the micro structure in the solid state by using the heat from friction for the aluminum-casting alloy, which has a higher specification. It was initially applied to aluminum alloys . The basic concept of FSW is remarkably simple. A non-consumable rotating tool with a specially designed pin and shoulder is inserted into the abutting edges of sheets or plates to be joined and traversed along the line of joint. 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.

The aluminum and its alloys have profound application in the design due to their of lightweight fortification structures and integrated protection system low density, high specific strength, high specific energy absorption capability, good corrosion resistance, good thermal conductivity, less sensitivity to adiabatic shear banding and thermoplastic in stability aluminum and its alloys possess Young's modulus, strength and ductility, lower melting point and less sensitivity to strain rate forbids it's usage as Armour material. Multi-layering of target or spaced structures, in extruded products or in combination with other materials, is

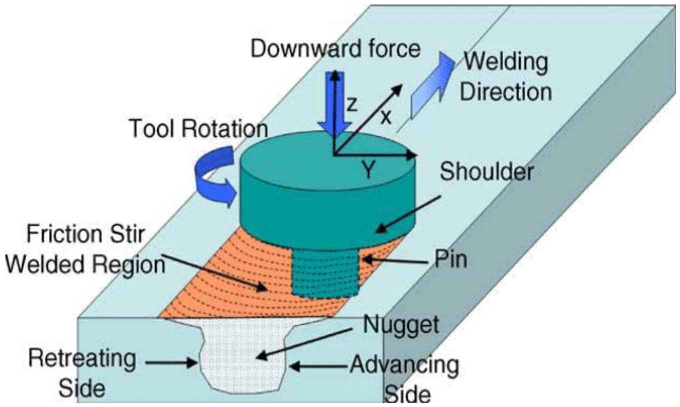

Figure 1: Schematic drawing of friction stir welding

Literature Review

.1. S. Chainarong and S. Suthummanon[1] The Material used in the experiment is a SSM 356 aluminum alloy. The cylindrical pin used as the stirring tool. The tool has a shoulder diameter., pin diameter. and pin length of 20 mm, 5 mm and 3.2 mm, respectively. And these Scholars was taken as the parameters of friction stir processing for SSM 356 aluminum alloys were studied at three different traveling speeds: 80, 120 and 160 mm/min under three different rotation speeds 1320, 1480 and 1750 rpm.

These Scholars was conclude by this experiment is the surface of specimen is improved by the friction stir process. However, investigation did not find any defects with the stirred. The hardness of the area was influenced by the thermal both retreating and advancing with increased hardness for all experimental conditions compared to that of base metal. But for the stir zone, the hardness can be either increased or decreased. The condition that increased the hardness is traveling speed at 120 and 160 mm/min with any rotation speed. The condition that reduced the hardness is travel speed at 80 mm/min with any rotation speed. The highest hardness, obtained at 1750 rpm with travel speed at 160 mm/min. An increase of 59.07% compared to the base metal. The average maximum tensile strength after using friction stir processing is equal to 188.57 MPa, an increase of 11.8% compared to the base metal. It was found that the conditions providing strength to pull up the average is at the speed around the 1750 rpm and at the travel speed at 160 mm/min.

Experimental Procedure

3.1. Material Properties

The base material employed in this study is a aluminum alloy 6061.

Table 1: Chemical compositions (% weight) of the Al-6061 alloy:

Element	Mg	Si	Cu	Zn	Ti	Mn	Cr	Al
Amount (%)	0.85	0.68	0.22	0.07	0.05	0.32	0.06	97.7

Processed, while the rotating pin deforms rather generates a ‘stirring’ action which locally heats up and creates severe plastic deformation in the material. After plunging to the required depth the feed is giving to the setup in terms of welding speed.

After done the Experimental Process then we are measuring the Surface Roughness test in by using Surface tester (Mitutoyo Surf test SJ-210). And done the hardness test by using Rockwell Hardness testing machine and measure hardness of Al-6061 plate (parent and processing plate). And finally done the Tensile test by using Universal Testing Machine (Zwick Roell Universal Testing Machine). Finally measure the tensile Strength and Elongation of Al-6061 material after done the FSP.

Results and Discussions

4.1. Effect of Surface texture on Friction Stir Processing:

From table 4.1 it is evident that for a plain tapered pin profile with rotational speed 900 rpm, as the traverse speed is increasing the surface roughness also increased for ϕ10 mm shoulder diameter but its vice versa in case of ϕ20 mm. Stirred roughness boundaries surface as a result of heat generated during stirring caused by rotation speed and travel speed. In the condition of rotation speed at 900 rpm and travel speed 125 mm/min on Shoulder diameter 10 mm stepped tapered plate, the high roughness was about 19.67µm, and found that The Minimum Surface Roughness was measured on the condition of rotating speed at 1800 rpm and travel speed 40 mm/min on Shoulder diameter 20 mm Plain tapered plate, the minimum roughness was about 2.597 µm. The variation in the surface roughness is minimal for plain tapered profile when compared with the stepped tapered profile. The pin surface area is more in case of stepped tapered profile when compared with plain tapered and this might be the cause for such high surface roughness values for stepped tapered profile.

We are observed that compare to parent metal the surface roughness value higher at on processing line. Due to the high rotation speeds and traverse speeds and high temperature the molecules are moving in jig jag manner then some Dislocations are forming. And also in the supporting bed there some slots are there so, due to the supporting material also some defects are forming. Thats why surface roughness values on processing line is higher than parent metal.

CONCLUSION

In this investigation an attempt has been made to study the effect of tool pin profiles and different rotational and welding speeds on mechanical properties and heat generation. From this investigations following conclusion are derived

- Increasing the welding speed will effect on tensile properties.
- Threaded shape is effectiveness on mechanical properties.
- Differences between peak temperatures of samples welded by different pin profiles are very little and not significant.

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