# Effect Of Tool Geometry On Surface Modification Of Aluminium 7075 By Friction Stir Processing

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**ABSTRACT**

**Aluminium 7075 is an aluminium alloy with Zinc as a primary alloying element. It is strong, with a strength comparable to many steels, and has good fatigue strength and average machinability. It has minimum resistance to corrosion than the other Aluminium alloys, but has significantly better corrosion resistance than the 2000 alloys.FSP is a process through which mechanical properties of the surface can be enhanced by reinforcing ceramic particles.In this surface matrix composite was fabricated on the surface of aluminium alloy (7075) with ceramic reinforcement using .Friction Stir Processing technique.Aluminium oxide and Boron carbide was used as reinforcement. The threaded cylindrical and square pin tools were used for the best distribution of Boron Carbide and Aluminium Oxide in the surface of base metal through the reinforcing techniques. The chosen FSP parameters such as traverse speed of 40 mm/min, tool rotational speed of 1000 rpm and 10 KN of axial load.**

**Keywords: Surface matrix composite, aluminium oxide and boron carbide particulars, AA6063, Friction Stir Processing**

**INTODUCTION:**

Aluminum is the second beautiful metal on earth. [1] Aluminium alloy has characteristics like low density, high specific strength, physical and mechanical properties and corrosion resistance Aluminium has good strength to weight ratio, high thermal conductivity and good corrosion resistance. Aluminium alloys were used in Transportation, Packages, Food and Beverage Containers. Though Aluminium has poor wear resistance; its tribological applications have been limited [3-8]

Friction stir process is a method that changes the properties of method through localized plastic deformation.FSP was originated from Friction Stir Welding.FSP is used in Automotive and Aerospace Industries[9]. Several researches uses different techniques like Square groove, V-groove, serial holes and Zig Zag holes to reinforce the additive particles via FSP temperature via FSP [5]

In this present investigation, surface property of Al 7075 is modified by reinforcing Boron carbide (B4C) powder particles, through square grooves, v-grooves, serial holes and zig Zag holes, via FSP. The distribution of B4C is examined with each reinforcing techniques and two different tool pin profiles by keeping surface composite volume fraction (22.38%) constant [6]. The tool that were used for FSP are Square pin and Threaded Cylindrical.

The tool used in FSP is a rotating tool with a pin and a shoulder.FSP help us to improve the toughness or flexibility. Friction between tool and workpiece results in localised heating that soften the workpiece.

**EXPERIMENTAL PROCEDURE**

The size of the aluminium plate used in this technique is 100mm×60mm×6mm.The chemical composition is shown in Table1.Boron Carbide and Aluminium Oxide were used as reinforcement.In the plates square groove, V groove, Serial holes and Zig Zag holes were made. [4]. Two different tool pin profiles were used as shown in the Figure.The Tool is made up of High Carbon High Chromium which is hardened. The tool shoulder diameter is 24mm, pin diameter is 8mm and pin length is 3.2mm constant for both tools.V groove and Square groove were taken at the end of the plates.In the centre of the plate serial holes and Zig Zag holes are drilled [7]. The space between each hole is 3.7mm .The dimensions for groove and holes were shown in table 2. The grooves and holes were packed with B4C particles and then a Single pass FSP is carried out [6].The constant rotational speed and transverse speed were fixed at 1200 rpm and 40mm/min respectively and their axial force is 40 KN which are kept constant. Rockwell general hardness (HR15T) test and Impact test were taken from the processed specimen. Apart from the hardness test tensile and compression tests were also done

**Table-1. Chemical composition of Al 7075**

| ELEMENTS | WEIGHT% |
|---|---|
| Al | 90 |
| Zn | 5.6 |
| Mg | 2.5 |
| Cu | 1.6 |
| Cr | 0.23 |

**Table-2. Dimensions for grooves and holes**

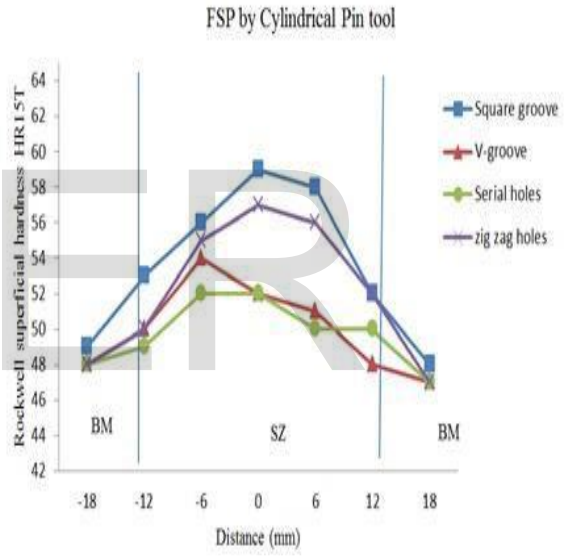
| | | |
|---|---|---|
| Square Groove | Width=1.91mm | Depth=3mm |
| V-Groove | Angle of V=65 | |
| Drilled Hole | Diameter=3mm | |


**Figure:** (a) Threaded Cylindrical Pin Tool
(b) Square Pin Tool

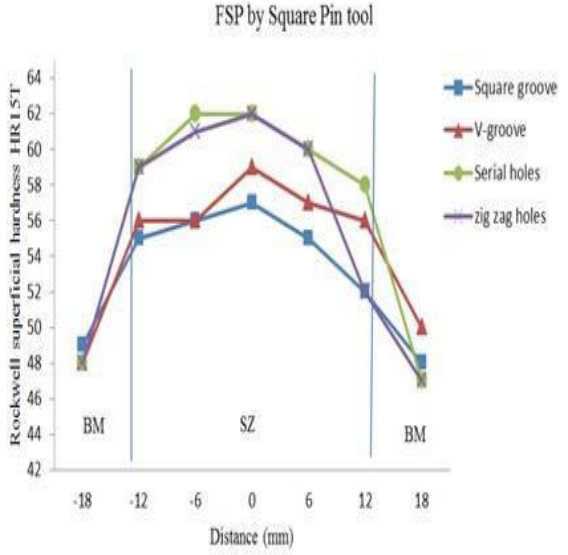
## RESULT AND DISCUSSIONS

### Hardness:

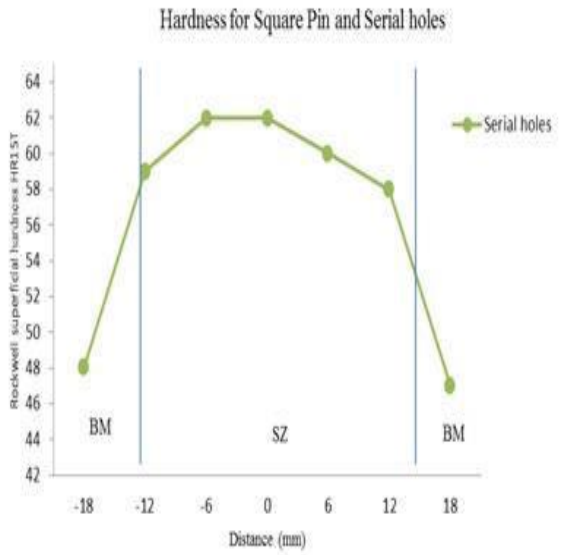
In this process at first Rockwell Hardness test is conducted.Rockwell hardness comparison is shown in the figure 3(a), 3(b).Two pin tools i.e.) Cylindrical Threaded Pin tool and Square Pin tool were used for the reinforcing technique.When Square pin tool is used in the Stir Zone higher hardness is obtained which is shown in the figure 3(b) [5].Uniform distribution of powder and higher hardness can be obtained only with the serial hole technique. Figure 3(c) separately shows the hardness value in the stir zone when B4C particles are packed into serial holes and Friction stir processing was done by square pin profile tool. Thus the serial holes reinforcing method can be selected to reinforce the additive particles with square pin profile tool based on hardness [6]. The increase in hardness in the stir zone is due to rigid spreading of B4C particles into the base metal surface. High hardness and rigid distribution is mainly due to Square pin tool.




3(a)




3(b)




3(c)

Hardness comparison for different additive Packing methods (a) FSP by cylindrical pin tool, (b) FSP by square pin tool, (c) hardness for FSP by square pin tool and serial holes

## Charpy impact test:

Impact strength comparison of base metal, cylindrical pin tool and square pin tool adapted with Boron carbide particles filled into Square groove, V groove, Serial holes and Zig-Zag holes was shown in the figure 4.When we are using the FSP processed tool the impact strength value gets decreased due to coating and increased The Firmness of serial holes reinforcement method hardness prepared by square pin tool is higher than other reinforcing method but lower than base metal. This shows orderly distribution Boron Carbide and Aluminium Oxide particles in the stir zone. Thus the square pin profile tool with serial holes method can be selected to reinforce the additive particles to obtain higher impact strength than other reinforcement methods.

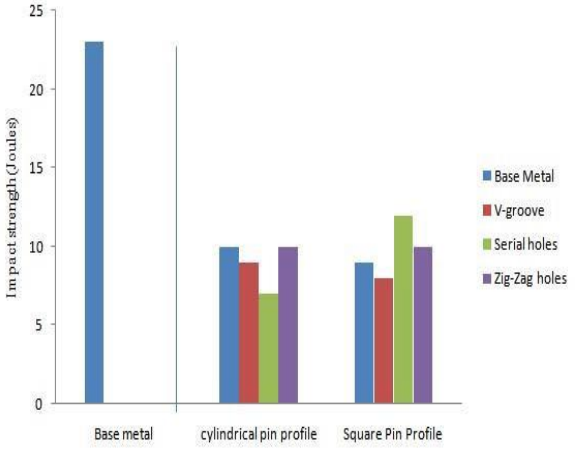



***Figure-4.*** Comparison of impact strength of base metal and FSP specimen

**Conclusion:**

Friction stir processing is an adequate method to Promote hardness by reinforcing Boron carbide particles into the base metal surface. The ultimate hardness and impact strength is achieved, when the Boron Carbide and Aluminium oxide particles are compressed into the serial holes and friction stir processed with square pin profile tool. Increased hardness in the Stir zone shows the uniform distribution of Boron carbide and Aluminium Oxide particles.

## REFERENCES

[1] D. C. Hofmann and K. S. Vecchio. 2005. Submerged friction stir processing (SFSP): an improved method for creating ultra-fine-grained bulk materials. Mater SciEng A. 402: 234–241.

[2] A. Dolatkhah, P. Golbabaei, M. K. Besharati Givi and F. Molaiekiya. 2012. "Investigating effects of process parameters on micro structural and mechanical properties ofAl5052/SiC metal matrix composite fabricated via friction stir processing" Mater Des. Vol. 37, pp. 458–64.

[3] R. Ramesh and N. Murugan. 2012. "Production and Characterization of Aluminium 7075 – T651 Alloy / B 4 C Surface Composite by Friction Stir Processing," No. 1, pp. 88–90.

[4] Min Yang, Chengying Xu, Chuansong Wu, Kuo-chi Lin, Yuh J. Chao and Linan An. 2010. "Fabrication of AA6061/$Al_2O_3$ nano ceramic particle reinforced composite coating by friction stir processing" Mater Sci. Vol. 45, pp. 4431-4438.

[5] Q. Liu, L. Ke, F. Liu, C. Huang and L. Xing. 2013. "Microstructure and mechanical property of multiwalled carbon nanotubes reinforced aluminum matrix. Composites fabricated by friction stir processing," Mater. Des, Vol. 45, pp. 343–348, March.

[6] H. R. Akramifard, M. Shamanian, M. Sabbaghian, and M. Esmailzadeh. 2014. "Microstructure and Mechanical properties of Cu/Sic metal matrix composite fabricated via friction stir processing," Mater. Des, Vol. 54, pp. 838–844, February.

[7] M. N. Avettand-Fènoël, A. Simar, R. Shabadi, R. Taillard and B. de Meester. 2014. "Characterization of oxide dispersion strengthened copper based materials developed by friction stir processing," Mater. Des, Vol. 60, pp. 343–357, August.

[8] A. Thangarasu, N. Murugan, I. Dinaharan and S. J. Vijay. 2014. "Synthesis and characterization of Titanium carbide particulate reinforced AA6082 aluminium alloy composites via friction stir processing," Arch. Civ. Mech. Eng., pp. 1–11.