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

Improving Wear Resistance in Aluminium 2024 by using Friction Stir Processing

Dr.K.Gowtham
Associative Professor,
Dept of Mechanical Engineering,
IFET college of Engineering,
Villupuram, India

Dr.B.Ganesa Balamurugan
Assistant Professor,
Dept of Mechanical Engineering,
IFET college of Engineering,
Villupuram, India

Mohanraj R
Dept of Mechanical Engineering,
IFET college of Engineering,
Villupuram, India

Nirmal W
Dept of Mechanical Engineering,
IFET college of Engineering,

***Abstract*— the purpose of this experiment was to improve the mechanical properties of Al 2024 aluminum alloy by friction stirring, a solid-state technique for micro structural modification utilizing the heat of friction and stirring. Silicon Carbide particles were consistently scattered in furrowed surface locales of an This innovation progressed the Al 2024 framework, resulting in better grain refinement, hardness and wear resistance properties. Wear tests measure the change in condition caused by friction and the results are determined by deformations, scratches and dents on the interacting surfaces. When the material hardness increases, the material wear resistance increases. Aluminum alloys made of semi-solid metal can be improved mechanically extremely effectively by using friction stir processing.**

***Keywords*— Friction stir treatment; Al 2024 aluminium alloy; Silicon Carbide, Wear Test.**

I. Introduction

Reaming (FSP) may be a strategy of changing the properties of metals by solid localized plastic misshapening. This misshapening is accomplished by squeezing a non-wearing instrument into the work piece and pivoting it in a rotational movement whereas pushing the instrument along the side through the work piece.

Friction Stir Processing (FSP) is based on the guideline of Friction Stir Welding (FSW) created and protected in 1991 by TWI Ltd, Cambridge, UK. FSP is a solid-phase welding technology that uses frictional heat and agitation to modify the structure, and has attracted attention in recent years for producing aluminum alloys with excellent specific strength, and extensive research is being conducted.

Friction stir treatment is a special technology that uses frictional heat in higher performance aluminum casting alloys to improve the solid structure. The mechanical properties of friction motion processing are improved by the granularity of the microstructure.

Semi-solid metal (SSM) is a possible injection molding technique, but it has been little developed in the last decade.

It is very strong compared to most aluminum alloys, and has average machinability, but the copper component of this alloy makes it susceptible to corrosion.

However, Cast aluminum is limited by porosity-causing mechanisms such as hardness, tensile strength, elongation, and fatigue strength.

Friction stir treatment is effective in progressing the mechanical properties and microstructure of aluminum combination castings.

In arrange to progress the wear properties, we use the technology that mainly focused on improving the wear resistance of the friction mixing process of aluminum alloy castings and also improving the microstructure, we study the mixing variable that affects the microstructure structure and mechanical properties of the mixing. Area and we move forward the forms utilized to progress the mechanical properties and research conditions, and extend the results to the industry.

This project is about to improve the wear resistance of aluminum alloys Al 2024 by friction stir processing, solid state engineering to modify the microstructure using the heat of friction and mixing. To avoid failure and have longevity of the component, The Nano-structural coating found to be fruitful in infusing new properties.

II. Methodology

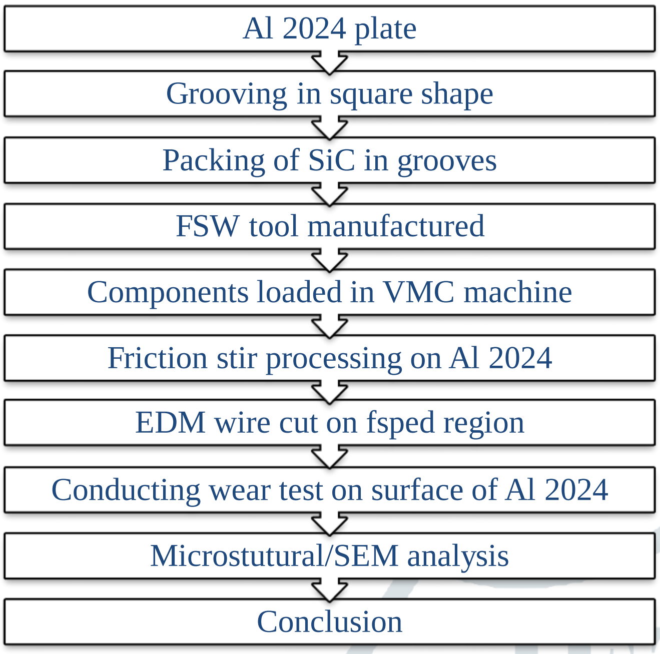

Figure 1: Block Diagram

III. Equipments and Testing

A. Parameter for Straight Cylindrical Tool Profile:

Table1: Specifications

PROCESS PARAMETERS	VALUES
Tool speed (RPM)	1200
Moving speed (mm/min)	15,25,30,50,60,75
Load (mm)	4
Tool inclination (^{0})	0
Shoulder diameter (mm)	20
Shoulder surface	Flat
Pin diameter(mm)	4
Pin length(mm)	3.5
Pin profile	Straight cylindrical
Canal width(mm)	2
Canal depth(mm)	1
Canal length(mm)	100

B. Tool Profile:

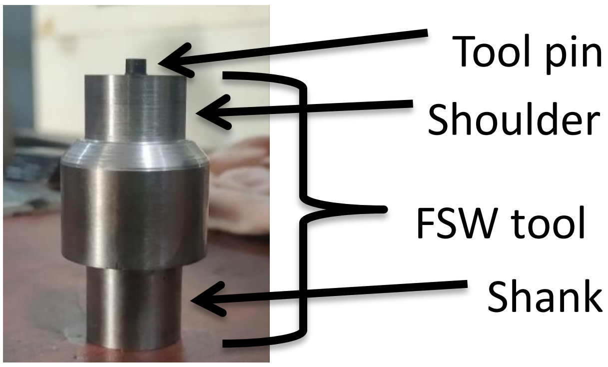

Figure.2: Straight cylindrical tool pin

Dimensions of FSW tool are:

- Shank diameter 20mm
- Shank length 20mm
- Shoulder diameter 20mm
- Shoulder length 25mm
- Pin diameter 4mm
- Pin length 3.5mm

A rotary tool with pins and shoulders is applied to a single material to enhance specific properties such as toughness and flexibility of the material in specific areas of the material's microstructure. This advancement is accomplished by utilizing better grains of a moment fabric with properties that strengthen the primary fabric.

C. Code for FSP:

```
%
N1 O0001
N2 G90 G80 G00 G17 G40 G54
N3 Z50.
N4 (PART NAME :t)
N5 (PROGRAMMER NAME :PC01)
N6 (CUT FEED RATE :15.)
N7 (DATE :4-3-2023)
N8 (TIME :13-4)
N9 (TOOL DIA =4.)
N10 (TOOL CORNER RADIUS =0.0)
N11 (COMMENT =No Text)
N12 (St Stock Offset =)
N13 S1200 M03
N14 G00 X0.0 Y-45. Z50.
N15 G00 Z1.
N16 G01 Z0 F1.5
N17 G01 Z-3. F1.5
N18 G01 Z-4. F 1.5
N19 Y45. F50.
N20 G00 Z50.
N21 Z50.
N22M30
%
```

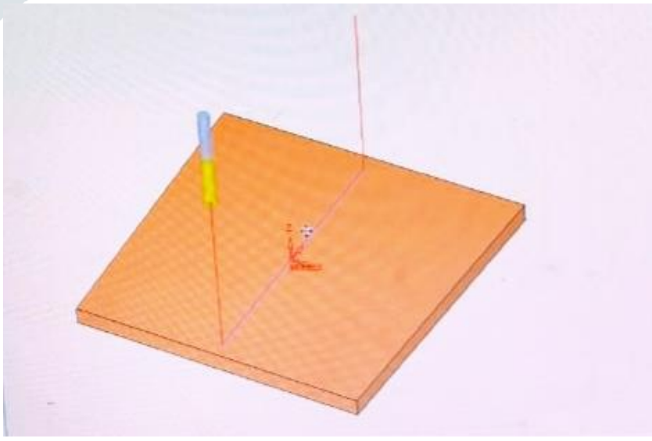

Figure.3: Simulation

D. Friction Stir Welding and Processing:

• Rotary tools are used with pins and shoulders on a single material to give specific property improvements. B. Improve the toughness or flexibility of the material.

• Contact between the apparatus and the work piece causes localized warming, making the work piece softer and more plasticized.

• The material undergoes strong plastic deformation, which leads to significant grain refinement.

• FSP modifies physical properties without altering the physical state, helping engineers to create high strain rate super plasticity, for example.

• Grain refinement occurs on the substrate and enhances the properties of the first material when mixed with the second material.

Figure.4: FSW process

Wear Testing Machine:

A. Pin-On-Disk

The rotating disc is pressed against by the ball or pin on disc wear testing machine. Measure the temperature, wear rate, wear volume, wear force, coefficient of friction (COF), and various other tribology parameters. For measuring the tribology characteristics of alloys, ceramics, polymers, metals, coatings, and solid lubricants, a pin on disc tribometer wear testing machine arrangement is excellent.

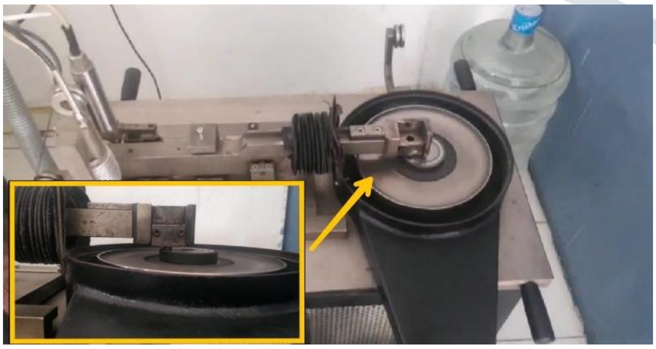

Figure.5: Pin-On-Disk

B. Parameters for Wear Test

Table2: Parameters of wear test

SPECIMEN NO.	TRANSVERSE SPEED	APPLIED LOAD (N)	SLIDING VELOCITY (m/sec)	SLIDING DISTANCE (m)
1	75	20	0.5	500
2	60	20	1.5	1500
3	50	60	0.5	500
4	30	60	1.5	1500
5	25	80	0.5	500
6	15	80	1.5	1500

IV. Result and Discussion

Wear tests were performed inside the enveloping environment utilizing a pin-on-disk tribometer with a appealing field associated inverse to the sliding surface. A 40 mm distance across plate was pivoted by an electric engine. The adhere was a barrel with a remove over of 8 mm and a length of 4 mm. The sliding surface of the stick could be a hemispherical surface. Both discs and pins were polished with 1200 grit ultra-thin sandpaper and cleaned with alcohol before each experiment.Nickel (a ferromagnetic metal with a purity of 99.99%) was used for the surface needle sample, while stainless steel was used for the disc. The pin and disc's initial Vickers hardness was 60 hp and 473 hp, respectively.Each sample was subjected to the test for 16 minutes. The experiment lasted for a total of 1.6 hours. Using a microbalance and gravimetry, pin or disc wear loss was measured.

Table1: Result of wear test

LOAD(N)	WEAR RATE(g)	
	239rpm	717rpm
20	0.02	0.008
60	0.025	0.031
80	0.023	0.025

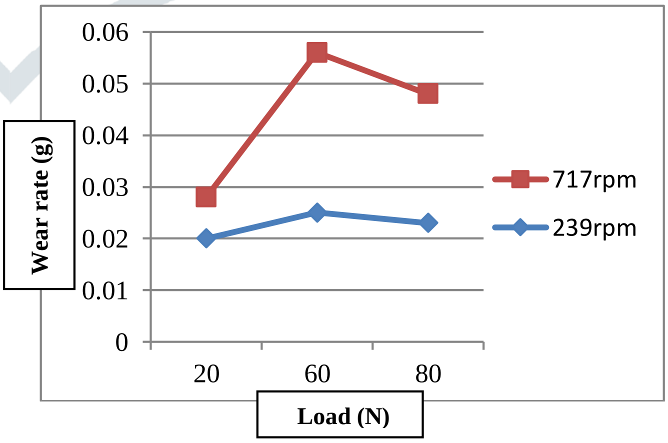

Figure.6: Graph

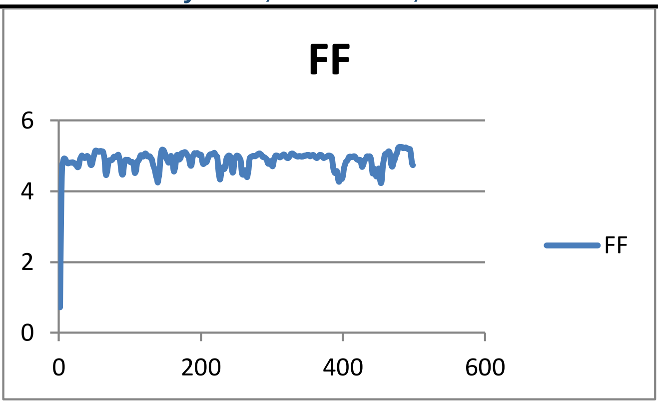

Figure.7: Time (seconds) vs. Friction force (N)

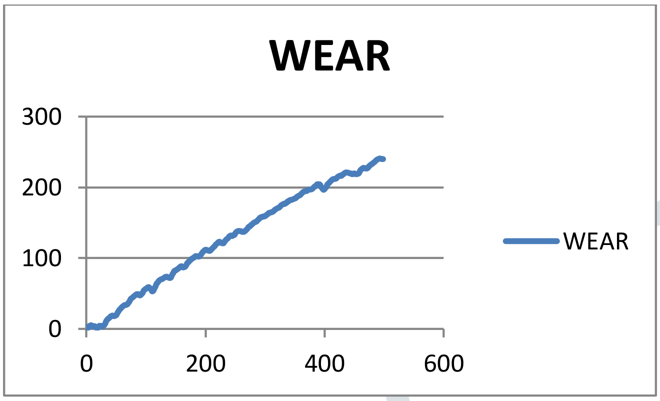

Figure.8: Time (seconds) vs Wear (microns)

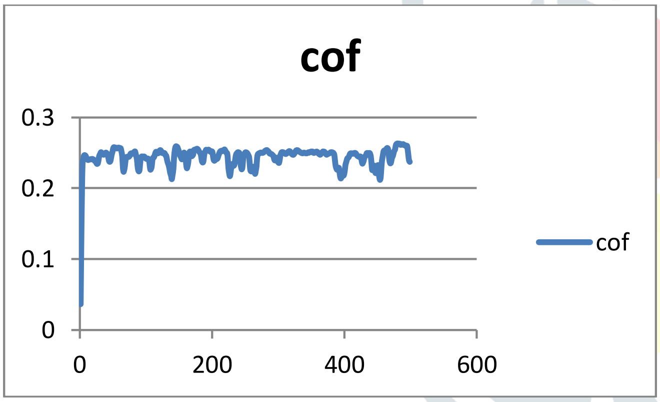

Figure.9: Time(seconds) vs Coeffient of friction

B) Sem Analysis:

SPECIMEN 1:

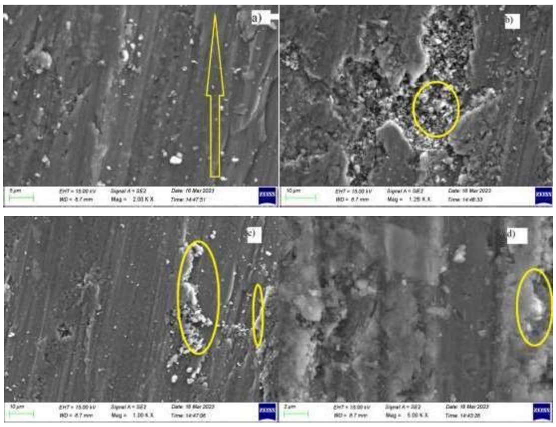

Figure.10: Shows SEM image of sample 2 of a) wear track b) cracks c) delamination d) void

Occurrence of the wear track on fig(a) due to sliding velocity(0.5m/sec) and distance(500m).Due to temperature conditions, cracks occurred in fig(b).Void formation at fig(d) occurs at the inter- face between Al2024 and SiC. The first location of void formation seems to be at the junction of grain boundaries and interfaces. Delamination occurred at fig(c) due to soft surface layer and low speed. Metal wear occurs through plastic displacement of the material at and near the surface, and exfoliation of particles to form wear particles. Greater rates of wear than the sum of the individual wear mechanisms.

SPECIMEN 2:

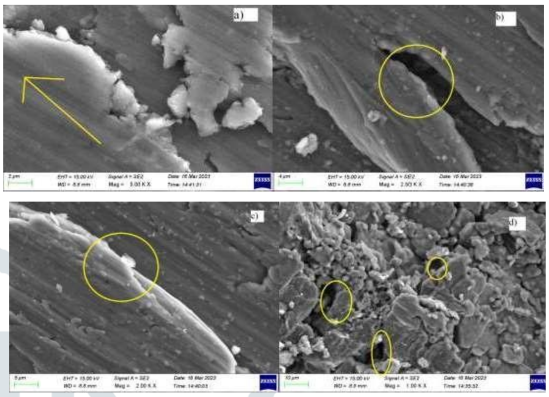

Figure.11: Shows SEM image of sample 2 of a) wear track b) cracks c) delamination d) void

Occurrence of the wear track on fig (a) due to high sliding velocity (1.5m/sec) and distance (1500m).Due to temperature conditions, cracks occurred in fig (b).At Fig. (d), Al2024 and SiC's interface is where voids arise. The first location for void formation appears to be where interfaces and grain boundaries meet. Delamination occurred at fig (c) due to low speed. Cracks in concrete surfaces are one of the early signs of structural deterioration

It is also very important for maintenance, as continued exposure leads to severe environmental damage.

SPECIMEN 3:

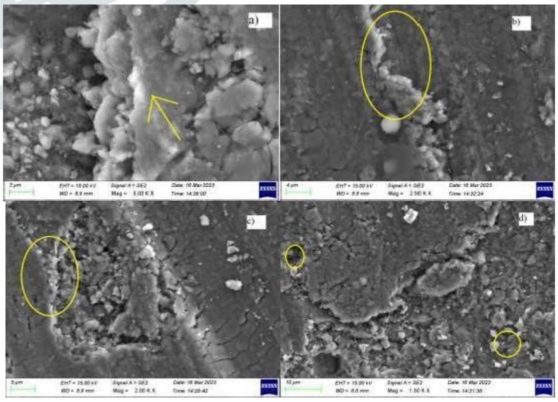

Figure.12: Shows SEM image of sample 3 of a) wear track b) cracks c) delamination d) void

Occurrence of the wear track on fig (a) due to increase in applied load (60N).Due to temperature decrease depends on speed (239rpm), cracks occurred in fig (b).The interface between Al2024 and SiC is where void creation at Fig. (d) Takes place.

The location of the first void creation seems to be where the grain boundaries meet the interface. Delamination occurred at fig(c) due to irregular surface layer. Cracks in the structure lead to material failure and local stiffness loss. Stress experienced by the composite initiates cracks and causes delamination.

SPECIMEN 4:

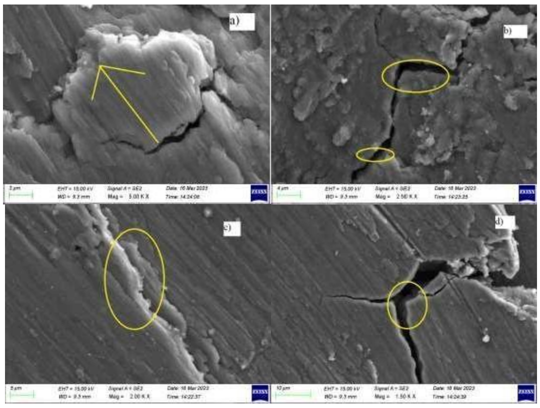

Figure.13: Shows SEM image of sample 4 of a) wear track b) cracks c) delamination d) void

Wear track appearance on fig. (a) As a result of sliding distance (1500m) and velocity (1.5m). Due to low temperature, cracks occurred in fig (b). At the interface between SiC and Al2024, a void forms in fig (d). At the intersection of grain boundaries and interfaces, this is believed to be the first cavitations site occurs. Due to the low speed and soft surface layer at fig. (c), delamination occurred. Voids can be caused by failures in the metallization process. B. Barrier deposition, electroplating, annealing and chemical-mechanical polishing. Metal wear occurs through plastic displacement of the material at and near the surface, and exfoliation of particles to form wear particles. Greater rate of wear than the sum of the individual wears mechanisms.

SPECIMEN 5:

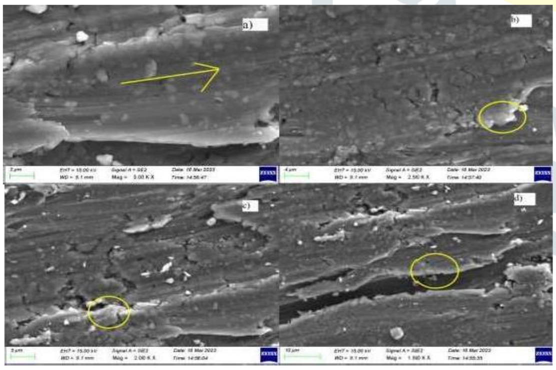

Figure.14: Shows SEM image of sample 5 of a) wear track b) cracks c) delamination d) void

Occurrence of the wear track on fig(a) due to low sliding velocity(0.5m/sec).Due to low temperature depends on speed(239rpm), cracks occurred in fig(b).Void formation at fig(d) occurs at the inter- face between Al2024 and SiC. The first location of void formation seems to be at the junction of grain boundaries and interfaces.

Delamination occurred at fig(c) due to low speed. Breaks on the concrete surface are one of the foremost reliable signs of corruption of the structure which is fundamental for the upkeep as well the ceaseless introduction will lead to the extraordinary hurt to the environment.

SPECIMEN 6:

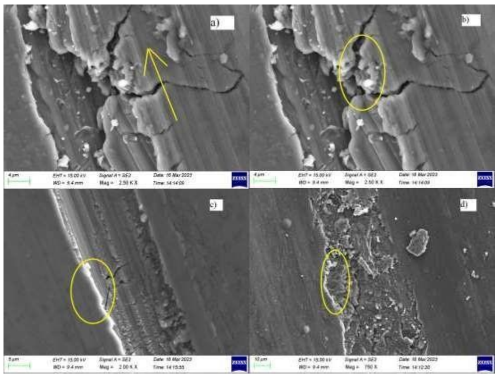

Figure.15: Shows SEM image of sample 6 of a) wear track b) cracks c) delamination d) void

Occurrence of the wear track on fig(a) due to sliding velocity(1.5m/sec) and distance(1500m).Due to temperature conditions, cracks occurred in fig(b).Void formation at fig(d) occurs at the inter- face between Al2024 and SiC. Delamination occurred at fig(c) due to soft surface layer. Inlet delamination and exit delamination are damage modes that occur in the transition section during drilling and are controlled by various process parameters (speed, feed rate, etc.).+-+

C) Microscopic View:

EXAMINATION AT REGION 1:

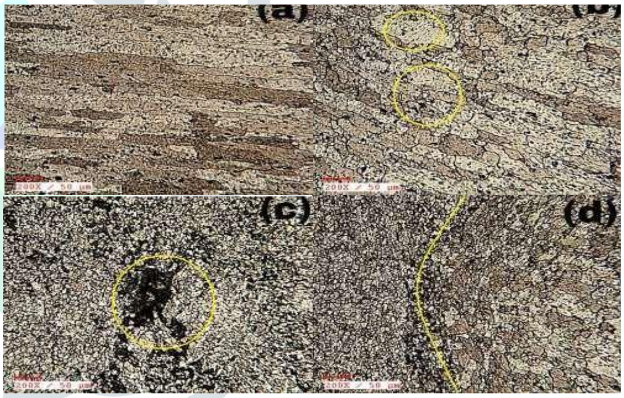

Figure.16: Shows sample 1 of the microscopic image of FSP zone of a) parent b) HAZ

EXAMINATION AT REGION 2:

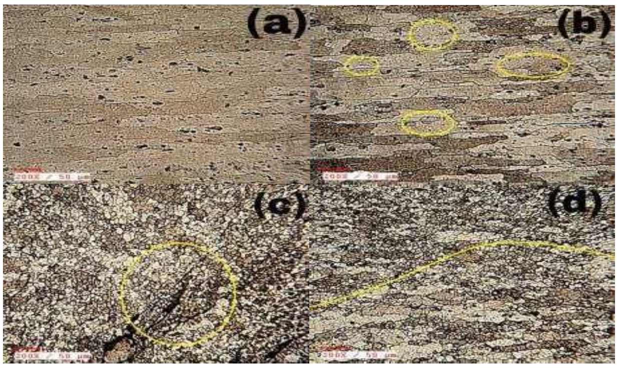

Figure.17: Shows sample 2 of the microscopic image of FSP zone of a) parent b) HAZ

EXAMINATION AT REGION 3:

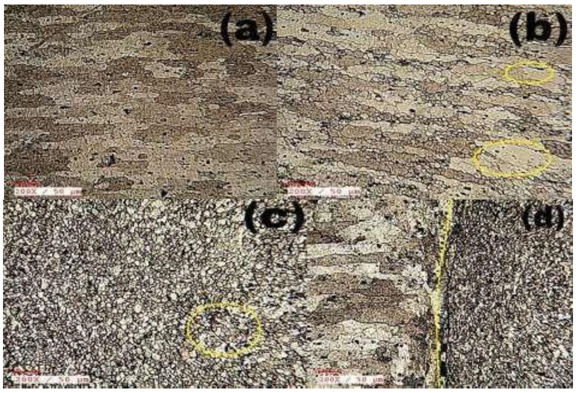

Figure.18: Shows sample 2 of the microscopic image of FSP zone of a) parent b) HAZ

V. Conclusion

A. Conclusion:

Based on the results of the semi-solid silicon carbide aluminum alloy sample used in this study, it can be concluded that:

(1) The friction stir procedure improves the surface of the specimen.

(2) The friction stir treatment also gives the macrostructure a uniform appearance**.** No defective components were found. The winding surface is smooth.

(3) The microstructure after the friction mixing treatment beneath all conditions features a highly refined structure comprising of silicon particles within the aluminum amalgam network, which are consistently dispersed over the whole mixing zone.

References

[1] P.B Berbon, W.H Bingel, R.S Mishra, C.C Bampton, M.W Mahoney, Friction stir processing: a tool tohomogenize nanocompositeealuminum alloys. Scripta Mater. 44 (2001) 61-66.

[2] Z.Y Ma, R.S Mishra, M.W Mahoney, Superplastic deformation behaviour of friction stir processed 7075Alalloy. Acta Mater. 50 (2002) 4419-4430.

[3] R.S Mishra, Z.Y Ma, I Charit, Friction stir processing: a novel technique for fabrication of surface composite.Mat. Sci. Eng. A. 341 (2003) 307-310.

[4] Z.Y Ma, R.S Mishra, M.W Mahoney, Superplasticity in cast A356 induced via friction stir processing.Scripta Mater. 50 (2004) 931-935.

[5] R.S Mishra, M.W Mahoney, S.X Mcfadden, N.A Mara, A.K Mukherjee, High strain rate superplasticity ina friction stir processed 7075 Al alloy, Scripta Mater. 42 (2000) 163-168.

[6] R.S. Mishra a,*, V.V. Stolyarov b, C. Echer c, R.Z. Valiev b, A.K. Mukherjee d "Mechanical behavior and superplasticity of a severe plastic deformation processed nanocrystalline Ti–6Al–4V alloy Materials Science and Engineering A298 (2001) 44-50

[7] Minoru Furukawa a, Zenji Horita b, Minoru Nemoto c, Terence G. Langdon d,* "The use of severe plastic deformation for micro structural control" Materials Science and Engineering A324 (2002) 82-89

[8] S.R Sharma, Z.Y Ma, R.S Mishra, Effect of friction stir processing on fatigue behavior of A356 alloy. ScriptaMater. 51 (2004) 237-241.

[9] M.L Santella, T Engstrom, D Storjohann, T.Y Pan, Effects of friction stir processing on mechanicalproperties of the cast aluminum alloys A319 and A356. Scripta Mater. 53 (2005) 201-206

[10] Y. Saito, H. Utsunomiya, N. Tsuji and T. Sakai "novel ultrahigh straining process for bulk materials development of the accumulative roll bonding process" Acta mater. [47][2], pp. 579-583, 1999

[11] Vladimir V. Stolyarov a, Y. Theodore Zhu b,*, Igor V. Alexandrov a, Terry C. Lowe b Ruslan Z. Valiev a "Influence of ECAP routes on the microstructure and properties of pure Ti Materials Science and Engineering A299 (2001) 59-67

[12] Yoshinori Iwahashi, Zenji Horita, Minori Nemoti, and Terence G. Langdon " The process of grain refinement in equal-channel angular pressing" Acta mater. [46][9] pp. 3317-3331, 1998

[13] Yuntian Theodore Zhu *, Terry C. Lowe "Observations and issues on mechanisms of grain refinement during ECAP process" Materials Science and Engineering A291 (2000) 46-53

[14] A.P. Zhilyaev a,b,*, B.-K. Kim d, G.V. Nurislamova a, M.D. Baro b, J.A. Szpunar c, T.G. Langdon d "Orientation imaging microscopy of ultrafine-grained nickel" Scripta materialia 46 (2002) 575-580