Morphological Depiction of Friction Stir Processed AA6063

[1]Rajendran V. K, [2]Prahadeeswaran.M, [3]Suresh Kumar.S, [3]GowriShankar.S

[1]Dept of Mechanical Engineering, AMK Technological Polytechnic College, Tamilnadu, Chennai, India.

[2]Dept of Mechanical Engg, Meenakshi Academy of Higher Education and Research, Chennai, India

[3] Dept of Mechanical Engineering, Panimalar Polytechnic College, Tamilnadu, Chennai, India

[1]veekayarr@yahoo.com, [2]prahadeesm@gmail.com, [3]sandysureesh@gmail.com,

[3]gowrishankarluck@gmail.com

Abstract: This attempt is to study the prospects and opportunities of introducing Boron Carbide powder in the AA6063 by using a technique named FSP. For doing Friction Stir Processing AA6063 was cut into required dimensions. After which the groove was taken in the dimensions of Length, Width, and Depth (100mm, 2mm and 2.5mm). Boron Carbide powder is inserted in the groove as calculated. For accomplishing the Friction Stir Processing two different profiled tools namely, Cylindrical and Square shaped were used. For Friction Stir Processing, process variables like axial load, speed and transverse speed were studied and taken as 12KN, 1400rpm and 40mm/min which are related to Friction Stir Process and AA6063 by previous literatures. Thus our aim is to analyze the morphological properties with optical photomicrography and Scanning Electron Microscope.

Keywords: AA6063, Boron Carbide particle, Cylindrical pin, FSP, Morphological property, Square pin.

I. INTRODUCTION

Aluminium alloys of 6000 series are well known for its good formability, corrosion resistance and weldability. [1] AA6063 a promising material for structural applications, transportation industries, and structural members in construction as welded structures. [2] This paper studies the in-situ casting by stir and squeeze method. Properties of the produced aluminium nitrate with aluminium alloy improved their strength as it acted as reinforcement. [3-6] FSW, a solid state fusion progression made-up at Welding Institute which is used for producing surface composite by a method called friction stir processing. FSP is also relatively novel multifunctional metal working method where the comparative shift among the tool and work plate creates high temperature which makes the two edges to be united by plastic flow.

[7] This work clearly shows the heat distribution of the friction stir welding process in simulation by finite element analysis and the results clearly revealed its distribution with respect to the parameters. [8] Performance of copper coated tool and copper tool were evaluated on machining by electrical discharge. [9] This FSP converts the mechanical work in to heat to structure the welding without the claim of heat from other source. [10] The diverse reward of the Friction stir processing is grain elegance, homogeneity, precise manage and changeable deepness of the processing sector zone. FSP an environment friendly procedure devoid of gases performs the weld without altering the profile and size of the workings.

[11] A tool with higher hardness than working material of unlike formed pins is placed into a working metal and moved the length of to progression in the province of interest. Abrasion flanked by shoulder of tool and work consequences in restricted heating, softens and plasticizes the FSPed zone. The rousing act of the turning pin makes severe plastic wrap in material. [12] In this work a vertical heavy duty milling machine is used for performing the friction stir processing by using nano silicon carbide for solid state processing and its effects on microstructure and mechanical properties are studied. Hence our aim is to produce a surface composite with boron carbide on AA6063 and to study its characterization.

II. EXPERIMENTAL PROCEDURE

Plates were purchased in well condition and cut into pieces with the dimension of 100mm X 50mm as length and breadth by Wire cut EDM process. Boron carbide an extremely hard ceramic material used in numerous industrial applications. B_4C is always slightly carbon deficient. Figure 1a & 1b shows B_4C powder`s SEM and EDAX. The volume of the grooved space was calculated as 1.2grams and calculated B_4C were reinforced in the grooved space of all the material.

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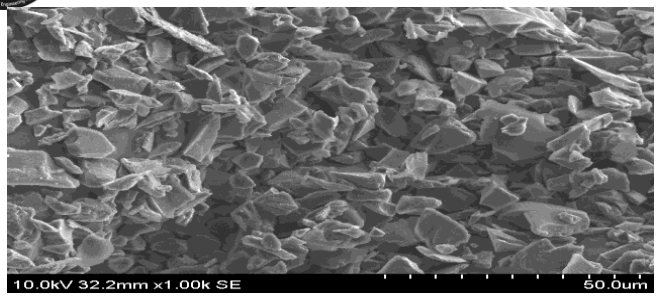

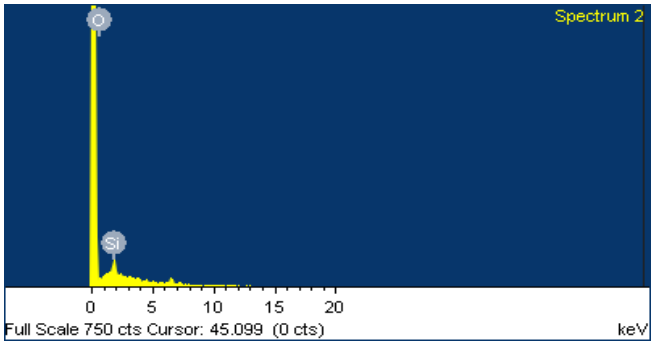

Figure 1a & 1b shows SEM and EDAX of Boron Carbide.

Tools were fabricated with dimensions of two different profiles namely, Cylindrical and Square tool with Pin diameter 6mm, Pin depth 2.7mm, Shoulder diameter 25mm as shown in Figure 2. FSP processing variables like Load, Tool feed and Transverse feed was analyzed and taken as 12KN, 1400rpm and 40mm/min. Then FSP was processed, in FSP two of the material was processed by cylindrical tool and the other two was with square tool

Figure 2 shows FSP tool of different profiles.

Figure 3a & 3b shows FSPed plates and processing procedure.

In each tool, one will be processed by reinforced material and the other one will be non-reinforced material as shown in Figure 3a. In Friction stir processing a tool with higher hardness than working material (High carbon High chromium steel) comprising of varying shaped pins is placed in AA6063 and moved on the length of grooved and processed region. Rubbing among shoulder of tool and AA6063 plate outcomes in restricted heat which smoothens and deforms the stirred nugget zone. The rousing deed of the gyratory varying shaped pins cause extreme plastic wrap in grooved area as shown in Figure 3b.

III. RESULT AND DISCUSSION

The FSP of AA6063 with and without B_4C particles of two different profiles were positively accomplished. The etchant openly revealed the microstructures of 6063 as in Figure 4a. The conversion in size of grains among nugget region and Heat Affected Zone is evidently seen in two different profiled tools in Figure 4b & 4c. The evolution zone in OM showed thermo-mechanically affected zone which is highly seen in square profiled tool in Figure 4c. Figure 4d & 4e shows the photomicrography of FSPed AA6063 with boron carbides.

The synthesis of this carbide produced a layer of exterior composites. B4C particles are scattered somewhat consistently in this upper layers as seen in Figure 4e and somewhat merged with AA6063 plates of the selected parameters. Rotation of the pinned tool caused higher forced sprain, which relocated these ceramic particles that are trampled inside of channeled groove. Figure 4b & 4c displays the primed surface composite and it evidently shows the dearth of no flaws by the side of the boundaries with superior bond linking the layered surface with the aluminium matrix. It also displays a lined formation near to the boundary indicating thermo-mechanically affected zone, which is a peerless facet of this working principle.

Figure 5a and 5b indicates the boron carbide ceramics which are almost distributed varyingly and mixed with AA6063. The stir action of gyrated pinned tool caused elevated strain, which shifts these ceramics that are packed in the channeled groove in nugget region. Broken, partly broken and scrupulously broken carbide ceramics are undoubtedly visible in SEM.

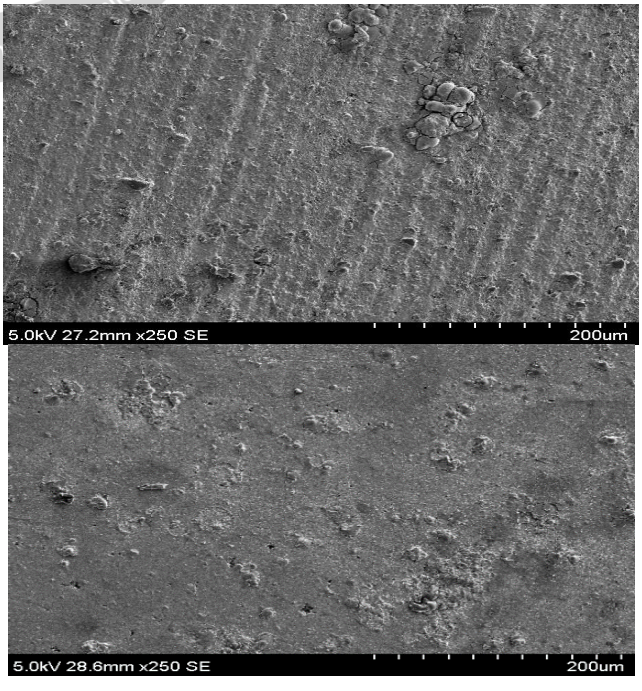

Figure 5a & 5b shows SEM of FSPed with cylindrical profile and Square profile.

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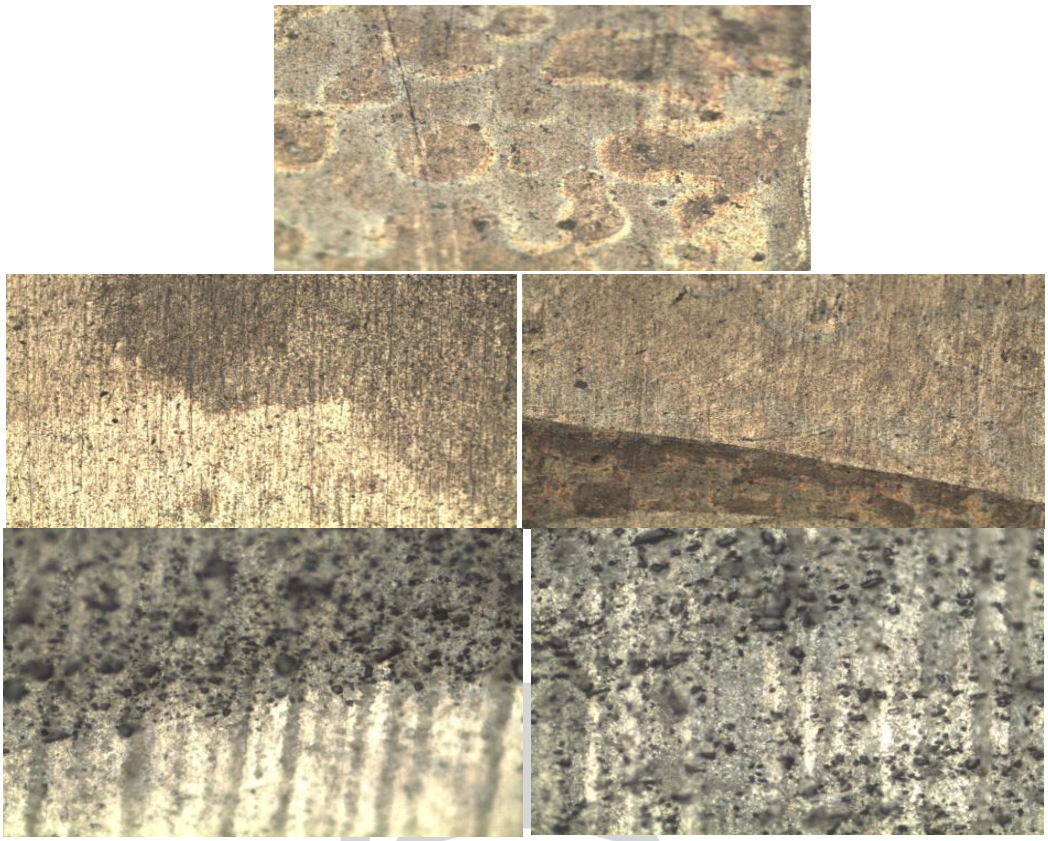

Figure 4a,4b,4c,4d,4e shows Optical Microstructures of AA6063,FSPed with cylindrical profile, FSPed with Square profile, FSPed with B_4C with cylindrical profile, FSPed with B_4C with Square profile.

IV. CONCLUSION

Thus, FSP of AA6063 with and without the presence of B4C particles with different tool profiles were successfully performed and characterized. The morphology of the stir zone by optical photomicrography and scanning electron microscopy directed fine grains and mere homogeneous dissemination of B4C particulates in AA6063/B4C surface composite and optical microscopy showed clearly the specialized zone called Thermo mechanically affected zone (TMAZ) . Furthermore, the square profiled tool yielded better metallurgical properties when compared with the cylindrical, as the edges of the tool made somewhat uniform distribution with lesser stagnation of boron carbide.

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