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Experimental Investigation on the Improvement of the Properties of the AZ80A Mg Alloy Joints Using Friction Stir Welding process

An experimental investigation was conducted with the basic objective of demonstrating the feasibility of joining the AZ80A Mg alloys using the technique of friction stir welding (FSW). Good quality joints free from defects were obtained for 5mm thickness AZ80A Mg alloy flat plates at a speed of rotation of 750 rpm with a traversing speed of 1.5 mm/min, by employing a FSW tool fabricated out of M35 grade High Speed Steel(HSS). It was experimetally observed that, the nugget zone (NZ) of the defect free weldments were found with fine sized, equally spaced & uniformly distributed grains when compared with that of the parent metal. Apart from this, the heat affected zone (HAZ) lying beside the NZ was found to possess larger sized near equaxied grains due to the effect of annealing. The weld zones were found to possess regions of slight softening nature when compared to that of the parent metal, arising from the dislocation of the lower densities. Moreover, the tensile strength of the defect free weldments was found to be around 78% of the parent metal, which seems to better than that of the strengths obtained using conventional joining techniques.

***Keywords**: Friction Stir Welding, AZ80A Mg alloy, Joint properties, Tensile Strength, Traversing speed, Tool rotational speed, Nugget zone, Heat affected zone.*

1. INTRODUCTION

Friction Stir Welding (FSW), an eco-friendly, innovative, unconventional joining technique invented and patented by The Welding Institute (TWI), United Kingdom is gaining interest & attracting many researchers in the recent years [1–5]. This is basically due to the attractive fact that, metals can be joined without reaching their melting. A rotating FSW tool, non consumable in nature, along with a pin and shoulder profile navigates in between the regions of the parent metal to be joined. When the FSW tool travels along the joint area, due to the friction between the FSW tool shoulder surface and the parent metal surface, heat is generated [6–10]. Apart from this, this FSW tool also leads to plastic deformation at the location of the joints, thereby enabling the joining of the parent metals, even when they are in the solid state. These reasons make this FSW technique a preferable one for many alloys in the recent years, when compared with that of the other conventional joining techniques [11,12].

Alloys including steel, copper, aluminium etc are found to be increasingly replaced by Magnesium (Mg) alloys in a wide variety of automotive, ship building and structural applications. These industries are preferring Mg alloys mainly due to their unique characteristic features including excellent damping property, sound castability, high machinability, low density value (1.74 g/cm^3), high thermal conductivity etc [13–20]. Even though the wider application of Mg alloys is dependent on feasible welding techniques, there is still a lack of suitable, effective & efficient joining techniques for majority of the Mg alloys [21–24]. Properties & features of Mg alloys like their strong cracking susceptibility, large energy requirement makes them difficult to be joined using the conventional welding techniques in an effective manner [25, 26]. In the recent years, Friction stir welding (FSW), an energy efficient & eco-friendly solid state joining method, with the ability for fabricating joints without melting the base materials, has gained the attraction of various experimental researchers working with the objective of joining light weight metals including Mg alloys [27–29].

2. SURVEY OF LITERATURE

Many recent experimental research investigations have proved that, the majority of the defects related with the joints (fabricated using traditional & conventional joining techniques) found to be eliminated completely due to the employment of FSW process, especially during joining of Al alloys [30–41]. For example, Yufeng Sun et al. [31] performed an experimental investigation during joining of 6061 – T6 Al alloys using FSW process and proved that, the formation of fine grains in the stir zone have resulted in the fabrication of joints,

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which can withstand shear loads to a maximum of 4500 N, which is very much when compared with that of the joints fabricated using conventional welding techniques. An attempt has been made to understand the micro-structural and mechanical properties of friction stir welding of 6063 aluminum alloy by Sai Sashank et al. [34]. The results revealed us that the employment of FSW process welding has produced fine recrystallized grains in the zone of nugget and recovered grains in the TMTZ (thermo-mechanically affected zone) along with appreciable amount of tensile strength and ductility at a combined 700 rpm of tool rotational speed and traversing speed of 60 mm/min.

Apart from this, the influence of various parameters of the FSW process on the quality of the fabricated AA6082-T6 weldments were predicted using an numerical modelling by Tongne et al. [36]. In this investigation, special focus were given to the under-standing of the evolution and formation of the banded structures during the FSW process. The investigators have developed an Eulerian–Lagrangian formulation based on the finite element (FE) analysis to quantify the level of impact of the various FSW process parameters in the evolution of the banded structures. The expe-rimental analysis revealed that the geometry of the FSW tool pin plays a significant role in the generation of the banded structures when compared with that of the other FSW process parameters. Likewise, another team of researchers lead by Ravi Sankar et al. [38] conducted an investigation to optimize various parameters of the FSW process including the speed, traversing speed, diameter of the FSW tool pin etc using 3 factors 5 level response surface design matrix and aimed to fabricate AA6061 Al alloy joints with improved mechanical properties including hardness. Their experimental works revealed that the fabricated joints were found to increase initially and then decline with the increase in the rotational speed. Apart from this, they also observed that the tensile strength of the fabricated weldments were found to be higher at employment of tools with minimum pin diameters, at reduced tool rotational speeds etc.

Apart from this, it was proved by many investigations that FSW process can be successfully applied to fabricate joints for dissimilar Al alloys and can also produce dissimilar Al alloy joints with imp-roved properties. Shen et al. [41] successfully fabricated dissimilar Al6022-T4/Al7075-T6 joints using the fric-tion stir spot welding process by employing different designs of tools at similar process parameters. They were able to obtain defect free weldments by employing an FSW tool with 3 grooves in the sleeve of the tool. The geometry of the tool design was to play a signi-ficant role in improving the intermixing of materials, metallurgical bonding and interlocking at the interface of the joints. The exhibited structure of intermixture has resulted from the combined effect of the bottom and top sheet materials encouraged by the grooves on the FSW tool sleeve's bottom portion and this design have been found to completely suppress the crack formation. The defect free joints were found to exhibit improved shear strength values with smaller sensitive values to the FSW process parameters.

Limited Investigations have been carried out on the FSW of Mg alloys under various conditions and process parameters [42–52] and a close review of these investigations reveals us that, majority of these investigations have done w.r.t. AZ31B Mg alloy [42 – 46] and limited investigations on joining of AZ61 [47 – 49], ZK60 [50, 51] etc. For example, the changes obtained in the tribological properties of the AZ31B Mg alloy joints fabricated during the FSW process by employing different tool shoulder profiles was investigated by Ganesa Balamurugan et al. [44]. This investigation showed us that, the strain hardening influences the properties of the materials while employing a concave tool shoulder and the size of the grains determines the material properties of the joints when a step tool shoulder was employed. Even though, enormous amount of experimental research works were carried out on the friction stir welding of the different Al alloys, the proclaimed & available knowledge on the FSW of Mg alloys is scant. Hence, a detailed experimental investigation on the FSW of Mg alloys especially AZ80A inevitable. In this experimental work, an endeavor has been carried out to understand in detail the changes in the microstructural characteristics in the various zones of the friction stir welded joints and their role in influencing the mechanical properties of the fabricated weldments.

3. INVESTIGATIONAL METHODOLOGY

3.1 Chemical Composition of Parent Metal

Wrought AZ80A Mg alloy in the form of 5mm thick flat plates was taken as the parent metal in this experimental investigation. The purchased wrought AZ80A Mg alloy flat plates was subjected to chemical tests to determine its various chemical composition and the tests revealed us that, the wrought AZ80A Mg alloy plates is com-posed of 7.84: Al, 0.7% Zn, 0.35% Mn, 0.052% Cu, 0.051% Ni, 0.109% Si, 0.048% Fe and the remaining percentage being Magnesium. The photographic view of a part of the wrought AZ80A Mg alloys used to fabricate joints in this experimental investigation is illustrated in the Figure 1.

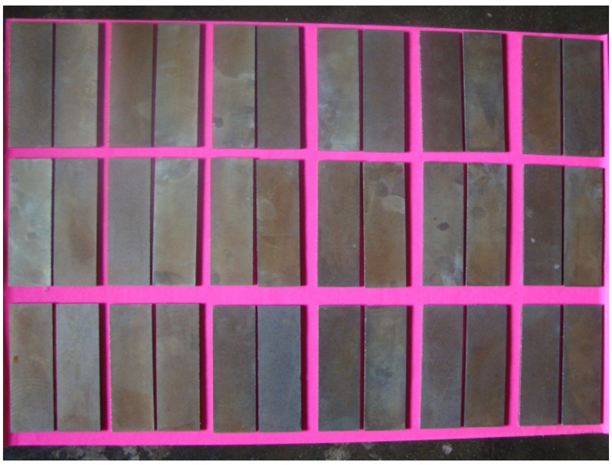


Figure 1. Photograph of the wrought AZ80A Mg alloy flat plates being firmly held in their respective position in the specially designed fixture of the FSW machine

3.2 FSW Machine Details

An in house designed, developed & fabricated friction stir welding machine of semi automatic nature is employed completely in this experimental investigation for fabricating AZ80A Mg alloy joints. The photographic illustration of the FSW machine employed in this investigation is shown in the Figure 2. This machine has a 810 X 400 mm sized working table, produce a maximum of 45 to 1500 rpm spindle speed together with a 0.25 – 50 mm /min rate of feed. It also houses a power spindle motor of 5kW capacity, which plays a significant role in providing axial force up to a maximum value of 3 ton from the upward direction onto the plates to be joined. Apart from this, the FSW machine can travel a distance of 510 mm along the X – axis, 400 mm both in the Z & Y – axes.

Figure 2. Photographic View of the Friction Stir Welding Machine used in this experimental investigation

The above mentioned FSW machine consists of a specially designed fixture, which can accommodate flat work plates with a maximum width of 75mm and a length of 200 mm. To enable better understanding of the arrangement of the work pieces in this fixture, an photographic illustration of the arrangement of the flat plates of AZ80A Mg alloy in the FSW machine's specially designed fixture is shown in the Figure 3.

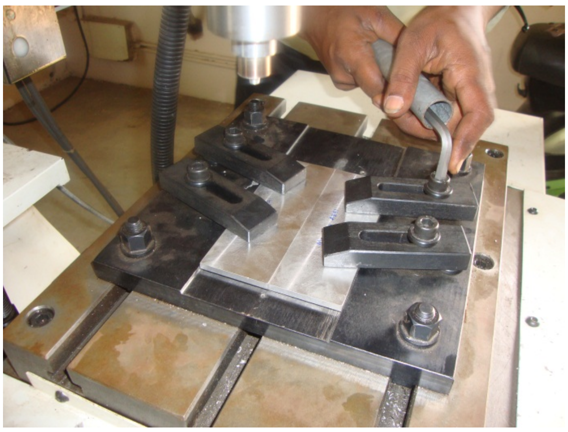


Figure 3. Arrangement of the flat plates of wrought AZ80A Mg alloy being rigidly fixed onto the surface of the FSW machine's specially designed fixture

3.3 FSW tool – Geometry & Material

From various detailed literature surveys, it was understood that, the material employed for fabricating the FSW tool plays a crucial & important role in determining the quality of the weldments being obtained [53–56]. Generally, it was observed that, the parent metal of investigation determines the material of the FSW tool [56, 57]. Hence, in this experimental investigation, based on the experience gained & suggestions shared by various experimental researchers, M35 grade of high speed steel (HSS) was taken as the base metal for fabricating the FSW tool and the tool was fabricated as per the design documents and after subjecting it to suitable heat treatment so as to achieve an hardness of 60 – 61 HRC, followed by cooling process, it becomes suitable for carrying out the FSW process.

Tool design seems to play an appreciable amount of role in determining the various factors like volume of plastic deformation, generation of ideal volume of frictional heat, regulating the flow of the material (in plasticized state) in a uniform manner etc [58–61]. As a result, sufficient amount of care & consideration must be taken, during the design of FSW tool profile.

In this investigation, a tool with a tapered cylindrical pin profiled tool was used for fabricating AZ80A Mg alloys joints using the FSW process. The different photographic views of the above mentioned FSW tool is shown in the Figure 4. The dimensions of this FSW tool can be summarized as consisting of a 30 mm diameter shoulder along with a 7 mm to 4 mm tapered (for a length of 4.75 mm) cylindrical pin profile.

Figure 4. Photographs of the taper cylindrical pin profiled FSW tool employed in this experimental investigation

3.4 FSW process parameters

Speed of rotation of the tool, traversing speed (i.e., feed rate), force from upward direction (axial force), tilt angle of the FSW tool, depth of penetration etc are some of the important parameters of the FSW process, which were found to play an significant part in determining the microstructural characteristics and various mechanical properties of the fabricated joints [62–65]. Since the basic objective of this experimental investigation is to understand the level of feasibility of joining the AZ80A Mg alloys using the technique of friction stir welding, and to have a better knowledge on the role of various

FSW process parameters in determining the various properties of the fabricated joints, the complete sequence of experiment was carried out using different combinations of two different process parameters namely speed of rotation of the FSW tool and traversing speed (i.e., rate of feed). The other parameters of the FSW process namely axial force, depth of penetration of the FSW tool pin profile being kept at constant values. These values include a 5 kN value of axial force, depth of penetration of the FSW tool pin being 4.75 mm. Table 1 describes in detail, the list of the various parameters and their different combinations adopted during this experimental investigation on the FSW process for joining of AZ80A Mg alloy joints.

Table 1. List of the varying parameters and their different combinations employed in this investigation on FSW process

Specimen No	Traversing Speed, mm/min	Speed of rotation of the FSW tool, rpm
I	0.5	500
II	1.5	500
III	3.0	500
IV	0.5	750
V	1.5	750
VI	3.0	750
VII	0.5	1000
VIII	1.5	1000
IX	3.0	1000

3.5 Fabrication of AZ80A Mg alloy joints

FSW of AZ80A Mg alloy flat plates are carried out in such a way that the welding direction is normal to the rolling direction of the specimen plates. Further, it is ensured that necessary care was taken in order to avoid distortion during the joining process and the joints were fabricated using the single pass welding technique. The various photographs taken during the fabrication of the various joints with different specimen no (from I – IX) by the FSW process is illustrated in the Figure 5.

It is clearly visible form these photographs that, the flat plates of AZ80A Mg alloy after being placed in the special fixture of the FSW machine, the tapered cylindrical pin profiled tool is made to penetrate into the joint region of the two flat plates in a gradual manner. Once the FSW tool pin has made its maximum penetration depth of 4.75 mm & the shoulder surface of the FSW tool has made its complete contact with the surface of the joint region, then the FSW machine's operating mode is switched onto the automatic mechanism mode, where the traversing speed of the machine is engaged in automatic travel manner, thereby permitting the FSW tool to travel over the remaining length of the joint surface with the already set values of speed of rotation & rate of feed.

A careful observation of the Figure 5 helps us to understand the different flow patterns of the chips arising on the surface of the joints, as the tool shoulder travels over the entire length of the flat plates of AZ80A Mg alloy. The difference in the flow patterns of the chips arises mainly due to the differences in the combination of adopted FSW process parameters.

Figure 5. Different flow patterns of the chips arising on the surface of the joints, as the tool shoulder travels over the entire length of the flat plates of AZ80A Mg alloy under different combination of FSW process parameters

4. EXPERIMENTAL INVESTIGATIONS & RESULTS

4.1 Surface Appearance of fabricated joints

Figure 6 shows in detail, the photographs of the part of a series of AZ80A Mg alloy flat plate joints fabricated using the FSW process under different combinations of FSW process parameters namely speed of rotation of the FSW tool and traversing speed of the FSW tool over the work piece surface, using a tapered cylindrical pin profiled tool. Even though, the majority of the fabricated joints are found to be defect free, it was described by many researchers in their experimental papers, that, a joint cannot be considered as defect free by visual inspection.

They should be observed and analysed at lower magnification (10X) using devices like optical microscope to find out the welding defects in microscopic as well as in macroscopic level [66, 67]. The welded joints can also be further subjected to Scanning Electron Microscope (SEM) analysis.

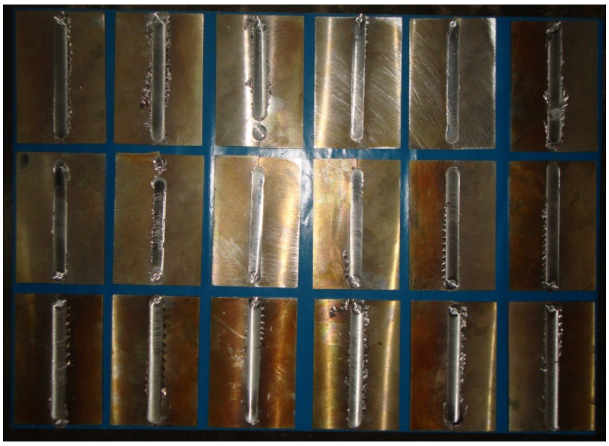


Figure 6. Photographs of a part of the AZ80A Mg alloy joints fabricated under different combinations of various FSW process parameters using tapered cylindrical pin profiled tool

4.2 Identification of defect free weldments

The fabricated weldments are segregated and arranged as per the specimen no and sample weldments from each specimen are observed using the optical electron microscope under different standard magnifications. Table 2 describes in detail the macrostructures of some sample weldments of different specimen numbers and the defects associated with those fabricated joints.

By studying and analysing the macrostructural images of the weldments fabricated under different combinations of the FSW process parameters, we can understand that, the two FSW process parameters namely speed of rotation of the FSW tool and traversing speed of the FSW tool over the joint surface have played a combined role in determining the quality & soundness of the joints being fabricated. These macrostructural images of the fabricated weldments further reveal that, completely defect free joints were fabricated at a speed of rotation of 750 rpm along with a combined traversing speed of 1.5 mm/min (specimen no.V), under a constant axial force of 5kN, while employing a taper cylindrical pin profiled FSW tool.

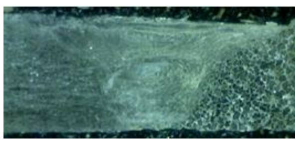
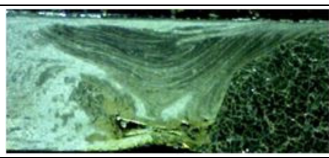
4.3 Characterization of FSW zones

The Input from severe plastic deformation and exposure to high temperature within the stirred zone during FSW process leads to recrystallization and development of texture within the stirred zone. Thereby, resulting in precipitate dissolution and coarsening around and within the stirred zone [68,69]. Based on microstructural characterization of precipitates and grains, three distinct zones namely nugget zone (NZ), thermo-mechanically affected zone (TMAZ) and heat affected zone (HAZ) have been identified as shown in Figure 7.

The optical micrograph of the parent metal i.e. AZ80A Mg alloy is illustrated in Figure 8 (a). Presence of coarse grain structure together with reasonable amount of sub grains can be seen in the optical microscopic image of the parent metal. Apart from this, Figure 8 also illustrates in detail, the optical microstructural images of the various zones of the friction stir welded joint namely heat affected zone (Figure 8(b)), thermo-mechanically affected zone (Figure 8(c)) and nugget zone (Figure 8(d)). By carefully observing and studying these microstructural images, we can understand that, there exists a variations in the microstructural images w.r.t that of the unaffected parent metal.

It can be seen that, the parent metal consists of unequally spaced, unevenly distributed, coarse, large sized grains. At the HAZ (heat affected zone), we can see that, the grains have been subjected to partial plastic deformation, due to the stirring action of the taper cylindrical pin profiled FSW tool. Likewise, the grains in the TMAZ (thermo mechanically affected zone), have experienced dynamic phase transformations due to the generation of the appreciable amount of frictional heat, by the movement of the FSW tool shoulder over the joint surfaces.

Table 2: Macrostructural Observation of joints fabricated at different combinations of FSW process parameters

Macrostructure of fabricated weldments			
Observation	Pin hole on the retreating side	Defect Free Joint	Pin holes at the bottom of weld nugget
Specimen No	I	V	IX
Tool rotational speed	500 rpm	750 rpm	1000 rpm
Speed of rotation of the FSW tool	0.5 mm/min	1.5 mm/min	3.0 mm/min

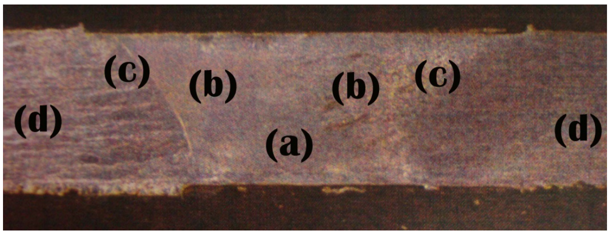
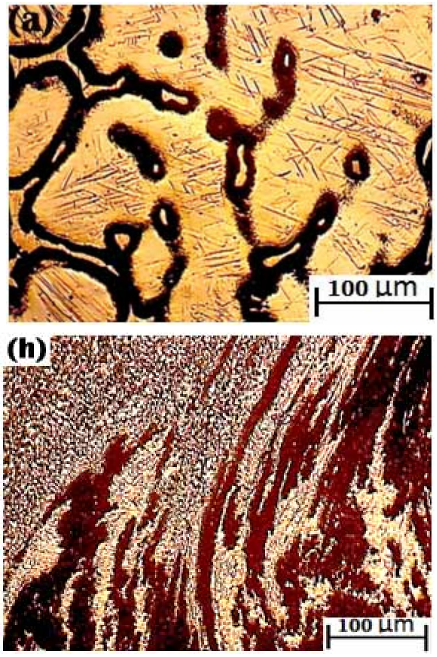


Figure 7. Photographic illustration of the different regions of FSW portion: (a) nugget zone (NZ); (b) thermo-mechanically affected zone (TMAZ); (c) heat affected zone (HAZ) and (d) unaffected parent metal

We can also observe that, the nugget zone is found to possess fine sized, uniaxial, equally spaced grain structures. This transformation of the coarse grain structures of the parent metal completely into fine sized grains in the nugget zone of the friction stir welded joints, have taken place due to the dynamic recrystallization process, resulting from the generation of frictional heat in an ideal volume and appreciable amount of plastic shear deformation.



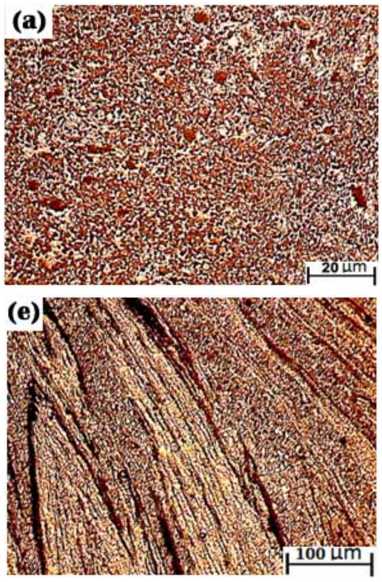


Figure 8. Optical microstructural images of the (a) Parent metal i.e., AZ80A Mg alloy and optical microstructural images of the defect free joint (Specimen no.V) at (b) Heat affected zone (c) Thermo mechanically affected zone and (d) nugget zone

4.4 Hardness Distribution & Observation

The distribution of the hardness of the joints fabricated using the FSW process is found to be significantly influenced by the grain size generated in the various region of the fabricated weldments [70–73]. As it has been observed by many experimental research works that, the dislocational slip is controlled by the grain boundary regions, leading to the fact that, the surfaces having smaller sized grains will possess higher strength or larger values of hardness[74,75]. Figure 6 graphically illustrates the measured values of hardness of the defect free joints belonging to Specimen No.V category and from these graphical illustration, it can be seen that, there is a slight decline in the value of the hardness along the regions of the heat affected zone, followed by gradual increase in the hardness values along the zone of TMAZ, then the hardness reaches its maximum values in the NZ.

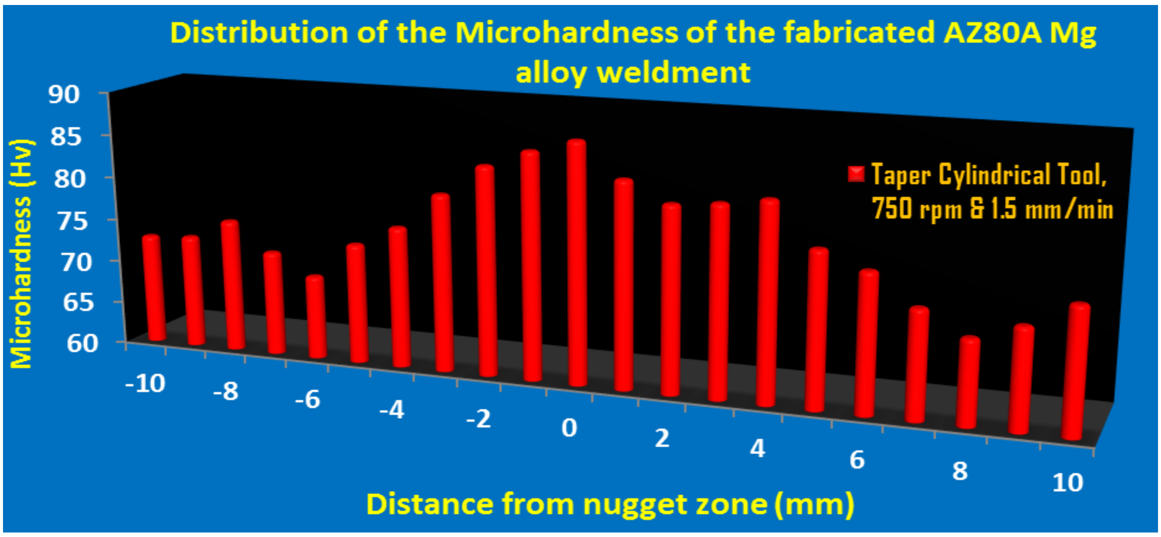
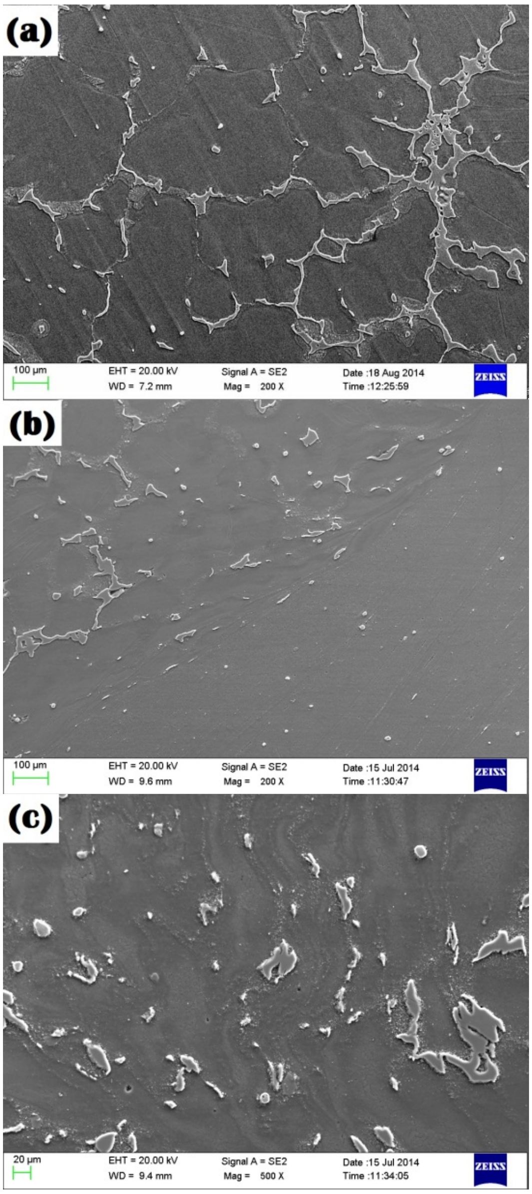


Figure 9. Optical microstructural images of the (a) Parent metal i.e., AZ80A Mg alloy and optical microstructural images of the defect free joint (Specimen no.V) at (b) Heat affected zone (c) Thermo mechanically affected zone and (d) nugget zone

This phenomenon is due to the fact that the larger the size of the grains, the smaller the value of the hardness. As a result, drastic rise in the values of the hardness can be observed whenever there is a reduction in the size of the grains [76–79]. In this experimental investigation, higher values of hardness have been recorded in the nugget zone, due to the generation of very fine sized grains during the FSW process. Similar observations have been recorded by many researchers [80–82]. For example, Starink et al. [81] have proved that, the waviness in the hardness values of the weldments similar to that illustrated in the Figure 9 occurs mainly due to the differences in orientation of the grain size in the various zones of the friciton stir welded joints.

4.5 SEM analysis of the joint surface

The defect free weldments (i.e., the joints fabricated under specimen no.V category) were observed through Scanning Electron Microscope (SEM) and the Figure 10 illustrates in details, the SEM images obtained for various FSW zones of the defect free weldments. Likewise, the SEM image of the parent metal i.e. AZ80A Mg alloy is also illustrated in the Figure 10 (a).



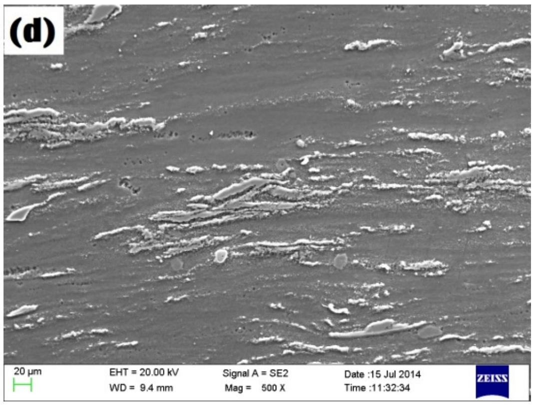


Figure 10. Scanning Electron Micrograph images of the (a) Parent metal i.e., AZ80A Mg alloy, (b) Heat affected zone, (c) Thermo mechanically transformed zone and (d) Nugget zone of the defect free joint (Specimen no. V)

From the Figure 10 (a), it is clear that, the parent metal is found to contain larger sized coarse, unevenly scattered $Al_{12}Mg_{17}$ compounds of intermetallic nature. But at the same time, when we observe the SEM images of the various zones of the friction stir welded defect free joints, for example in the Figure 10 (b), which illustrates the HAZ, we can see that, the action of stirring by the tapered cylindrical pin profiled FSW tool have occurred in an appreciable level and an marginal flow of transformed grains can be seen over the this region. Apart from this, the $Al_{12}Mg_{17}$ precipitates have seemed to be dissolved completely because of the ideal amount of generation of heat resulting from the suitable combination of the FSW process parameters including the tapered cylindrical pin profiled FSW tool, 5 kN axial force from upward direction, 1.5 mm/min speed of traverse and 750 rpm.

When we observe the thermo mechanically affected zone (TMAZ) illustrated in the Figure 10 (c), we can see the uniform flow of the plasticized grains together with the $Al_{12}Mg_{17}$ precipitates and plasticity of the metal have taken place in an appreciable manner, due to the proper fragmentation of the grains. Figure 10 (d) illustrates in detail the SEM image of the nugget zone (NZ). It is clearly visible that, the ideal stirring action by the taper cylindrical pin profiled FSW tool have directed the plastically deformed grains along the axes of rotation. The $Al_{12}Mg_{17}$ precipitates (white colored particles) have been found to be elongated and fragmented. Likewise, the grain matrix of the AZ80A Mg alloy has also been found to undergone plastic deformation exactly along the FSW tool axis.

4.6 Analysis of Tensile Fractography

A series of tensile tests were carried out as per the international ASTM standards, for the purpose of determining the mechanical properties of the AZ80A Mg alloy joints fabricated using the FSW process. The photograph of a part of the tensile specimens prepared as per the above prescribed standards is shown in the Figure 11. It was fund that the tensile strength exhibited by the defect free weldments (i.e., the joints fabricated under specimen no.V category) is 227 MPa, which is approximately 78.1% of the strength (290 MPa) of the parent metal.

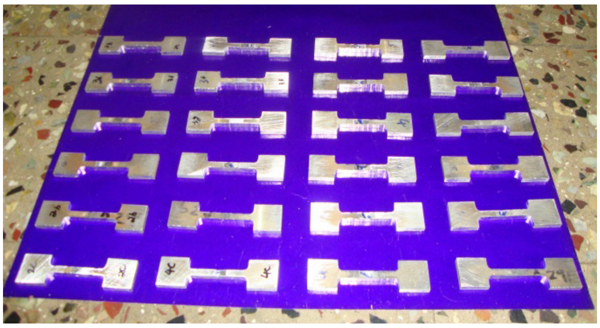


Figure 11. Photograph of display of a part of the tensile specimens of the fabricated AZ80A Mg alloy joints prepared as per the prescribed international ASTM standards

Likewise, the strength of yield exhibited by this defect free weldment is 128 MPa, which is around 66.3% of the parent metal (193 MPa). The associated % of elongation of this joint is 6.1%. This value of the tensile strength (227 MPa) exhibited by the defect free weldment fabricated under a speed of rotation of 750 rpm under a traversing speed of 1.5 mm/min by employing a tapered cylindrical pin profiled tool applied under a constant axial force of 5 kN is larger than the tensile strength of the Mg alloy joints fabricated using the conventional welding techniques.

5. CONCLUSION

In this investigational paper, detailed experimental works were conducted with the very basic objective of demonstrating the feasibility of joining the AZ80A Mg alloys using the technique of friction stir welding with different varying combinations of FSW process parameters namely speed of rotation of the FSW tool & traversing speed employing a tapered cylindrical pin profiled tool applied under a constant axial force of 5 kN. The experimental observations, investigational results recorded and analysed in the current investigation allow us to arrive at the conclusions, mentioned below:

- Defect free weldments were fabricated under a combination of speed of rotation of 750 rpm & traversing speed of 1.5 mm/min (i.e., joints fallingunder the category of specimen no.V).
- The coarse unevenly distributed grain structures of the aprent metal i.e., AZ80A Mg alloy have been transformed into very fine sized, uniaxial equally spaced grains in the nugget zone of the defect free weldments.
- The transformation of the coarse grain structures of the parent metal completely into fine sized grains in the nugget zone of the friction stir welded joints, have taken place due to the dynamic recrystallization process, resulting from the generation of frictional heat in an ideal volume and appreciable amount of plastic shear deformation.
- The distribution of the hardness of the joints fabricated using the FSW process is found to be significantly influenced by the grain size generated in the various region of the fabricated weldments. Higher values of hardness have been recorded in the nugget zone, due to the generation of very fine sized grains during the FSW process
- The tensile strength exhibited by the defect free weldments (i.e., the joints fabricated under specimen no.V category) is 227 MPa, which is approximately 78.1% of the strength (290 MPa) of the parent metal.

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ЕКСПЕРИМЕНТАЛНО ИСТРАЖИВАЊЕ У ЦИЉУ ПОБОЉШАЊА СВОЈСТАВА СПОЈЕВА ЛЕГУРЕ AZ80A Mg ПРИМЕНОМ ЗАВАРИВАЊА ТРЕЊЕМ СА МЕШАЊЕМ

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Главни циљ истраживања је био да покажемо да је могуће спојити легуре AZ80A Mg применом технике заваривања трењем са мешањем. Добили смо квалитетне спојеве без присуства дефеката код равних лимова дебљине 5 мм од легуре AZ80A Mg при брзини ротације од 750 rpm и брзини кретања од 1,5 мм/мин помоћу алата израђеног заваривањем трењем са мешањем од брзорезног алатног челика M35. Експериментално је утврђено да се у „грумен“ зони спојева без дефеката налазе фина зрна, равномерно распоређена и на једнаком међусобном растојању у поређењу са истом зоном код матичног метала. У зони утицаја топлоте, која се налази поред „грумен“ зоне, нађена су крупнија зрна, једнакоосна, што је последица каљења.

У зонама заваривања налазиле су се регије нешто мекше природе у поређењу са истим регијама код матичног метала, а што је резултат дислокације мањих густина. Затезна чврстоћа спојева без дефеката је износила око 78% матичног метала, што је знатно боље од чврстоће добијене применом конвенционалних техника заваривања.