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Effect of Under Surface Cooling in Friction Stir Processing of Aluminum Alloy 6082: A Review

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***Abstract* - Friction Stir processing (FSP) is a new technique of Friction Welding. This technology is used in automobile and aerospace industries because it reduces the defects produces by conventional fusion welding techniques. Now in days Friction Stir Processing is introduced as a new process for microstructural surface modification of various materials or for changing the properties of metal by producing intense localized plastic deformation in the material. The main principle of this technique is based on FSW. The tool pin plunged in the plate and plastic deformation is produced by heat is generated due to rotational motion of too. Cooling of specimen during FSP is also a new research to improve the mechanical properties of base metal. The present investigation shows the effect of cooling of specimen on mechanical properties during FSP. It has been observed from this review paper that the effect of cooling of specimen greatly affected the mechanical properties of metal as compared to dry conditions. It has been observed that the values of yield strength and micro hardness increases in cooled region of welded joint.**
***Keywords*: Friction Stir Processing (FSP), Micro-Hardness, Mechanical Properties, Tensile Strength, Microstructure, Under Surface Cooling**

I. INTRODUCTION

The major issue in these days is to join the metals by defect free joint. There are number of new techniques introduced in to join the metals by welding. But the main types of welding technology are divided into two categories Fusion welding technology and solid state welding technology. Solid state welding gives better mechanical properties as compared to the fusion welding. Some other advantages like no filler material required, non-consumable tool, no oxidation of material are also attract the researchers.

FSW is considered to be the most significant development in metal joining in a decade and is a ‘‘green’’ technology due to its energy efficiency, environment friendliness, and versatility. As compared to the conventional welding methods, FSW consumes considerably less energy. No cover gas or flux is used, thereby making the process environmentally friendly. The joining does not involve any use of filler metal and therefore any aluminum alloy can be joined without concern for the compatibility of composition, which is an issue in fusion. R.S.Mishra (2005).

As a solid state welding technology, the friction stir welding (FSW) process may provide a feasible approach to join dissimilar Al to Mg alloys. The weld zone showed defect free dissimilar weld, but the micro hardness distribution in the weld was uneven and erratic hardness spikes exhibited hardness values as much as three times that of the base material. Attempts to join Mg to Al alloys by means of FSW, however, have resulted in the formation of brittle intermetallic phases leading to poor mechanical properties for the joint [11] Zettler R.

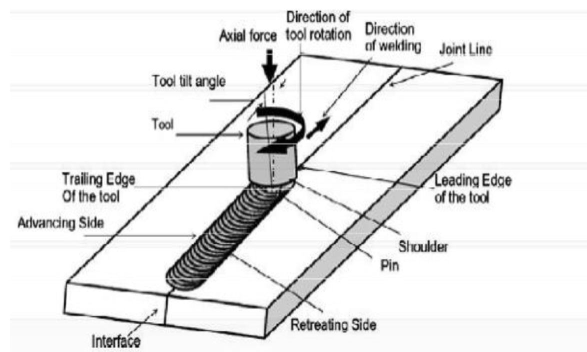

Fig. 1 Set Up of a FSW Process

Sato investigated the friction stir weld ability of Al alloy 1050 and Mg alloy AZ31. Temperature measurements with thermocouples showed a peak temperature above 460 _C in stir zone of the weld. The stir zone was irregular in shape, containing a large volume of eutectic solidification microstructure of Mg + Al12Mg17. Cracks were observed in the stir zone. Sato Pantelis The key difficulty is to control the liquation (i.e. liquid formation) and growth of Mg–Al intermetallic compound in the welding process. This necessitates lowering the heat input. Submerged friction stir welding (SFSW) is a new variation to FSW. Fu Rui-dong the principle of submerged welding process is that the welds are placed in a liquid medium, and weld processing takes

Place under a specific ambient temperature. This process is suitable for alloys that are sensitive to overheating during the welding process. Rui-dong Fu Materials and Design 32 (2011) 482. Upadhyay and Reynolds investigated thermal boundary conditions and their effects on the mechanical properties of AA7050-T7 FSW joints welded in sub ambient water and a _25 _C liquid medium. The ultimate tensile strength throughout the range of parameters tested showed improvements. Upadhyay P, Reynolds.

II. LITERATURE REVIEW

Liu *et al.* (2010) revealed that the precipitate deterioration in the thermal mechanically affected zone and the heat affected zone is weakened with the increase of welding speed, leading to a narrowing of softening region and an increase in lowest hardness value. Tensile strength firstly increases with the welding speed but dramatically decreases at the welding speed of 200 mm/min owing to the occurrence of groove defect. During tensile test, the joint welded at a lower welding speed is fractured in the heat affected zone on the retreating side. While at higher welding speed, the defect-free joint is fractured in the thermal mechanically affected zone on the advancing side.

Zhang *et al.* (2011) with increasing rotation speed, the hardness of the stir zone (SZ) gradually increases due to the increase in dislocation density. The tensile strength first increases from 600 to 800 rpm and then reaches a plateau in a wide rotation speed range. After that a remarkable decrease in tensile strength occurs owing to the formation of void defect. The joint welded at lower rotation speed tends to be fractured in the SZ. At higher rotation speeds, the hardness increase in the SZ makes the fracture locations of defect-free joints move to the thermal-mechanically affected zone (TMAZ) or heat affected zone (HAZ).

Darras *et al.* (2007) observed that FSP refines the microstructure from an average grain size of about 6 µm to an average grain size of about 3–4 µm. The results showed that the hardness of the processed sheets was extremely sensitive to the processing parameters. Increasing the tool rotational speed tends to decrease the resulting hardness and increasing the tool translational speed, limits the amount of grain growth, because of decrease in heat input. The minimum hardness values were observed at the interface between the thermo mechanical affected zone (TMAZ) and the heat affected zone (HAZ), where the hardness values were smaller than those of the base material. The hardness drop in the heat affected zone was attributed to no mechanical deformation (stirring) at this zone; however the peak temperature reached was enough to soften the material near the nugget.

Ma (2008) observed that the FSP can provide localized modification and control of microstructures in near- surface layers of processed metallic components. The FSP causes intense plastic deformation, material mixing, and thermal exposure, resulting in significant micro-structural refinement, densification, and homogeneity of the processed zone. The FSP technique can be successfully used for producing the fine-grained structure and surface composite, modifying the microstructure of materials, and synthesizing the composite and inter metallic compound in situ.

Mofid *et al.* (2012) his research demonstrates the use of submerged friction stir welding (SFSW) under water as an alternative and improved method for creating fine grained welds, and hence, to alleviate formation of intermetallic phases. A constant tool rotation rate of 300 rpm and travel speed of 50 mm/min was used. The air welded specimen had a relatively larger volume fraction of intermetallic compound, higher peak temperature in stir zone and significantly higher hardness in the weld center. The present study suggests that submerged friction stir welding under water resulted in lower peak temperature and because of lower heat input intermetallic compounds formation was limited.

Miracle (2005) and Funatani (2000) noticed that FSP enhances properties of the materials from different aspects. It densifies the microstructure, refines the grain size, results in closure of porosities and provides a convenient method to improve the surface properties by forming surface composites. Surface metal matrix composites (SMMCs) exhibit a unified combination of excellent tribological properties of the surface and high toughness of the interior bulk metal when compared with both metal matrix composites (MMCs) and monolithic materials.

III. CONCLUSION

The conclusions drawn from the present investigation are as follows.

1. The result confirmed that that the value of micro hardness is improving with the effect of cooling.
2. Dry condition produces less micro hardness than that of any other type of cooling.
3. Tensile strength also increases with increase in hardness value.
4. The fine grain size observed in cooled FSPed sample is responsible for its high hardness than the dry alloy.
5. It has been observed that no cracks and voids are present in the processed part. A small amount of porosity is present in some of the samples.

IV. FUTURE SCOPE

For the processing of aluminium alloys, optimization of welding parameters like tool rotation speed and processing speed can be done. FSW process is slow process as compare to other fusion welding techniques; therefore the possibility of performing FSP at higher speeds, with better properties of the metals, should be explored. Advanced alloys of magnesium are currently replacing other alloys due to their strength and corrosion resistance. Research should be done for processing of aluminium alloys to advance alloys of magnesium etc.

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