EXPERIMENTAL INVESTIGATION ON MECHANICAL AND METALLURGICAL PROPERTIES OF THE FRICTION STIR WELDED AA7075-T651 ALUMINIUM ALLOY JOINT

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ABSTRACT

Friction stir-welding of AA7075 has become widely used in the fabrication of light-weight structures requiring high strength-to-weight ratios and superior corrosion resistance. The friction stir-welding (FSW) process plays a key role in determining the joint's characteristics. Like a microstructure of different positions along the thickness of the aluminium alloy plate has been investigated. Friction stir welding (FSW) is a relatively advanced method which has been systematically developed for joining of all type of aluminium alloys. Consistent with the more conventional methods of friction welding, which have been practiced recently, in friction stir weld is made in the solid phase. The mechanical test l data confirmed an increase mechanical and metallurgical e behavior after changing of its microstructure and also explain about mechanical properties such as tensile strength, micro hardness.

KEYWORDS: Friction stir welding (FSW), AA7075Aluminum alloy, Microstructure, Micro hardness, Tensile strength

INTRODUCTION

Friction Stir Welding (invented, patented and developed at TWI) is a derivative of conventional friction welding , which enables the advantages of solid-phase welding to be applied to the fabrication of long butt and lap joints, with very little post weld distortion. The solid-phase weld formation produced by FSW provides three important metallurgical advantages when compared to fusion welds in aluminium alloys; first, joining in the solid-phase eliminates cracking; second, there is no loss of alloying elements through weld metal evaporation and the alloy composition is preserved; and finally, the crushing, stirring and forging action of the welding tool produces a weld metal with a finer grain structure than that of parent metal.AA7075 Introduced by Alcoa in 1943, alloy 7075 has been the standard workhorse 7XXX series alloy within the aerospace industry. It was the first successful Al-Zn-Mg-Cu high strength alloy using the beneficial effects of the alloying addition of chromium to develop good stress-corrosion cracking resistance in sheet products. Although other 7XXX alloys have since been developed with improved specific properties, alloy 7075 remains the baseline with a good balance of properties required for aerospace applications. Alloy 7075 sheet and plate products have application throughout aircraft and aerospace structures where a combination of high strength with moderate toughness and corrosion resistance are required. material.

The stirring of the tool minimizes the risk of having excessive local amounts of inclusions. FSW offers an efficient solution to this challenging task since the joining takes place much below the melting temperatures and results in less distortion, lower residual stresses and fewer defects. The pin not only rotates but also traverses along the length of the weld, enabling to weld the two plates. The tool rotation and weld direction are similar on one side called as Advancing Side (AS) and opposite on the other called as Retreating Side(RS). Due to this in an FSW joint there exists an asymmetry which is the unique characteristic of the joint. in all the studies reported earlier on FSW method the effect of the process parameters on the joints has been studied, however there is a necessity to study the effect of the same on producing similar alloy joints of AA7075 due to their heavy usage in marine, aerospace, mechanical and applications. With this motive the present work is attempt to investigate mechanical and metallurgical properties of friction stir welded AA7075-T651 high strength heat treatable aluminum alloy. FSW joint is created by friction heating with simultaneous severe plastic deformation of the weld zone material.

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EXPERIMENTAL METHOD

The chemical composition of Aluminum alloy 7075 T651 as rooled condition is shown in table1

Table1; Chemical composition of AA7075 –T651 alloy

Wt%	Al	Zn	Mg	Cu	Cr	Fe	Mn	Si	Ti
AA7075	91.5	5.5	2.2	1.2	0.18	0.5	0.3	0.4	0.2

Welding parameters and tool specification: For this investigation we utilized indigenous friction stir welding machine in our CEMAJOR laboratory, the machine have been operated with optimized welding parameter with the axial load of 14 kN The axial force, torque and penetration depth values could be recorded simultaneously during each welding operation. For this sudy Tool used was made of High carbon steel and composed of a shank, flat shoulder(diameter mm),threaded probe(diameter mm).The depth of probe tip from the upper surface of the aluminium plate was also kept constant. Fig1 shows the principle of friction stir welding.

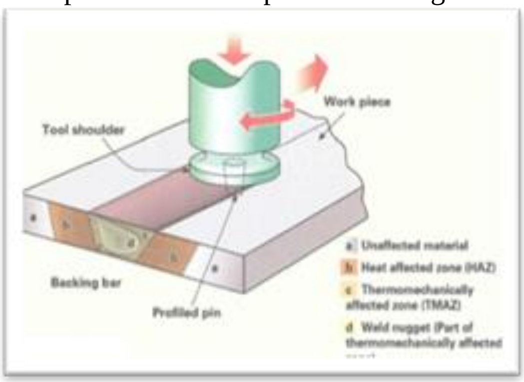


Fig.1.Friction stir welding

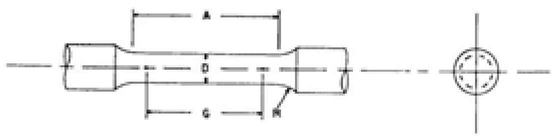


Fig.2.Tensile test specimen

Micro hardness test: The hardness were carried out in load 0.5Kn with interval period of 15 seconds of Vickers hardness test machine, both the heat affected zone (HAZ) and the thermo mechanical affected zones are lower than that of base metal (BM), The difference between HAZ and WN is attributable to the grain refinement. in WN, caused by intensive stirring action to influence the improve the hardness properties . The softest points of the joints correspond to the failure locations in tensile tests.

Tensile test: The welded joints were cut in to the transferred direction to fabricate the smooth tensile specimen as per the American society of tested materials E8M shown fig2. The tensile test were carried out in universal testing machine of 100kN and the average two fracture load condition specimen taken for final conclusion.

Microstructure Analysis: The sample for microstructure studies were initially slice and the polished using standard and end up with etched with Keller reagent to reveal the microstructure, the metallographic analysis were carried out using a light optical microscope (Make Carl ZEISS, model ;Imager.A2m) and the microphotographs were taken in various region.

RESULT & DISCUSSION

Micro hardness: The results of micro hardness along the weld zone in various region like nugget at top surface and nugget at middle and nugget at bottom surface. The micro hardness values ranged from 138 HV to 160 HV and showed some changes for the different nugget zones of the friction stir welded aluminum alloy joints. The transformation trend was based on contact between tool shoulder and substrate metal , in this case result shows bottom nugget zone hardness is quit higher hardness then top nugget zone because the heat penetration in bottom surface is lesser then the top surface. The highest micro hardness 160VH formed in bottom nugget zone.

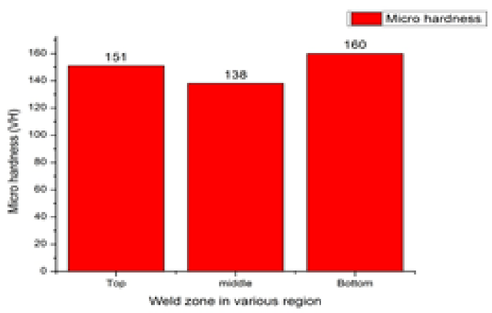


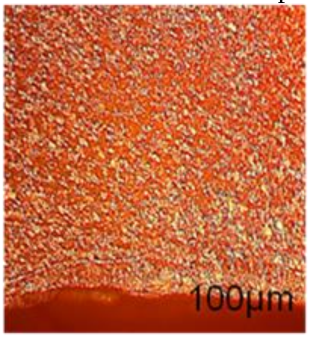
Fig.3.Micro hardness of nugget region

Tensile strength: Based on these results, the UTS results can be compared the substrate and friction stir welded AA7075 aluminum alloy joints. Table 2 shows the tensile properties of substrate and FSW joints. the value of the UTS is highest were performed in base metal is 585MPa

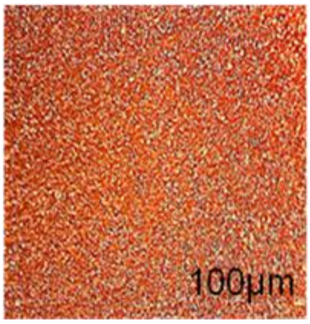
Table.2.Tensile properties

Specimen	UTS (MPa)	Yield Strength(MPa)	%Elongation
Base metal7075	**585**	**504**	**11**
FSW7075	**365**	**265**	**9**

Microstructure: The weld zone is a nearly V-shaped and widens near the top surface due to the tool geometry and the close contact between the tool shoulder and the upper surface of the weld. In this case, the stirred material from the top is carried down by the threads and deposited in the weld nugget. None of the macroscopic defects typical of fusion welded Al based alloys were observed in the FSW specimens. the metal does not melt, no casting structure is formed as in conventional fusion welding, and neither does shrinkage occur in the weld zone due to solidification. In Weld nugget the grains are refined.. This refinement is the result of dynamic recrystallization i.e. a combined action of high rate strain and elevated temperatures.



Nugget at top



Nugget at middle

Nugget at bottom

Figure.4. Various microstructure profile at weld region

Such recrystallized structure is characterized by a very low level of residual stresses, excellent ductility and mechanical properties superior to those of HAZ (Heat Affected Zone).

CONCLUSION

FSW processes have welded joints of 7075 Al alloy with a good appearance and without defect weld is obtained .the tensile strength of FSW is 365MPa with yield strength is 265 were obtained. The micro hardness of various nugget region are centre middle and top values are 138VH, 151VH and 160VH. However, in the present investigation the tensile strength and the hardness and microstructure in various nugget zone are analyzed.

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