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Effect Of Post Weld Heat Treatment On Micro Structure & Corrosion Behavior Of Aa 7075 Friction Stir Welds

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***Abstract*:** Aluminum AL7075 alloy is an attractive option for aerospace components in naval and defence applications due to its corrosion resistance and absence of melting related problems. This project reports the effects of post weld heat treatments, namely Peak age treatment and Retrogression and reaging on microstructure and mechanical properties of 12 mm thick friction stir welded joints of high strength AA7075 aluminum alloy. Welds were characterized for metallo graphy to carry out the micro structural studies using Optical Microscopy, hardness measurements were done using Vickers hardness tester. Potentio-dynamic polarization tests were carried out to determine the pitting corrosion behavior done using a basic electrochemical system. The results show that welds under peak age treatment (T-6) exhibit better mechanical properties compared to RRA treatment. Welds under Retrogression and reaging exhibit better corrosion resistance with marginal decrease in strength and which is attributed to the micro structural changes observed in both the weld joints.

1. INTRODUCTION

Grinding blend welding (FSW) is quickly getting to be acknowledged as a suitable assembling process for aviation applications. One potential territory of concern, be that as it may, is the erosion resistance of some FSW joints. Grating mix welding (FSW) is vitality effective, environment inviting strong state welding process. Due to the nonattendance of guardian metal liquefying and related issues, for example, weak dendrite structure, porosity, bending and lingering stresses, this procedure can be utilized for joining the greater part of the aluminum compounds.

In FSW process the material is subjected to exceptional plastic misshapening at raised temperatures because of the blending activity of a pivoting apparatus. Grating blend welding accomplishes strong stage joining by locally presenting frictional warmth and plastic stream by revolution of the welding instrument with coming about nearby microstructure change in aluminum combinations. The welding temperatures in FSW ranges between 425C–480C. The welding temperature never surpasses 80% of liquefying point and does not bring about dissolving but rather sufficiently high to bring about disintegration/overaging of fortifying particles in warmth influenced zone (HAZ), thermo-mechanically influenced zone (TMAZ) and the piece zone (NZ) prompting the development of a diminished area with debased mechanical properties by and large in warmth influenced zones [2, 3]. FSW causes grain refinement in the weld zone because of which the rigidity of the joint increments with little loss of malleability.

Numerous creators reported that post weld heat treatment of 7075 combinations at T73 temper enhances the consumption resistance. In any case, the quality is 10 – 15% less if there should be an occurrence of T73 temper when contrasted with T6 temper. The RRA treatment of 7xxx arrangement compounds recuperates the quality without debilitating the consumption resistance of the material. Post weld heat treatment is a suitable alternative to reestablish the quality of the joints by adjusting the size, shape and conveyance of optional reinforcing particles.

2. Mechanical Properties

The mechanical properties of 7075 depend enormously on the temper of thematerial.7075-0 Un-heat-treated (7075-0 temper) has most extreme elasticity close to 40,000 psi (275 MPa), and greatest yield quality close to 21,000 psi (145 MPa). The material has a prolongation (stretch before extreme disappointment) of 9–10%.

7075-T6

T6 temper 7075 has an extreme elasticity of 74,000–78,000 psi (510–572 MPa) and yield quality of no less than 63,000–69,000 psi (434–503 MPa). It has a disappointment stretching of 5–11%.

The T6 temper is typically accomplished by homogenizing the cast 7075 at 450C for a few hours, and afterward maturing at 120C for 24 hours. This yields the top quality of the 7075 amalgam. The quality is gotten for the most part from finely scattered estimated time of arrival and estimated time of arrival' encourages both inside grains and along grain limits.

7075-T7

T7 temper has an extreme elasticity of 73,200 psi (505 MPa) and a yield quality of 63,100 psi (435 MPa). It has a disappointment stretching of 13%.

T7 temper is accomplished by overageing (which means maturing past the crest hardness) the material. This is regularly refined by maturing at 100C-120C for a few hours and after that at 160C-180C for 24 hours or more. The T7 temper delivers a small scale structure of for the most part estimated time of arrival hastens. As opposed to the T6 temper, these estimated time of arrival particles are much bigger and favor development along the grain limits. This decreases the helplessness to stretch consumption splitting. T7 temper is comparable to T73 temper.

7075-T651

T651 temper 7075 has an extreme elasticity of no less than 67,000–78,000 psi (462–538 MPa) and yield quality of 54,000–67,000 psi (372–462 MPa). It has a disappointment prolongation of 3–9%.

The 51 postfix makes little difference to the warmth treatment yet signifies that the material is anxiety diminished by controlled extending.

7075-RRA

The retrogression and reage (RRA) temper is a multistage heat treatment temper. Beginning with a sheet in the T6 temper, it includes overageing past crest hardness (T6 temper) to close to the T7 temper. A resulting reaging at 120C for 24 hours gives back the hardness and quality to or practically to T6 temper levels. RRA medicines can be refined with a wide range of techniques. The general rules are retrogressing between 180C-240C for 15min-10s.

Properties:

Aluminium amalgam 7075 is an aluminum compound, with zinc as the essential alloying component.

It is solid, with a quality similar to numerous steels, and has great weariness quality and normal mach powerlessness,

It has less imperviousness to erosion than numerous other Al amalgams.

Its generally high cost restricts its utilization to applications where less expensive combinations are not appropriate.

3. RESULTS AND DISCUSSION

In this part results and talk are exhibited in seven areas.

1) Microstructure of base metal
2) Hardness of base metal
3) Corrosion of base metal
4) Microstructure of Friction blend weld
5) Hardness of Friction blend weld
6) Corrosion of Friction blend Weld

3.1 Microstructures of Base Metal of all tempers:

Normal organization of the base metal is given in Table 3.1 the Al-Zn-Mg-Cu framework was perplexing. It was accounted for that few intermetallic stages, for example, η(MgZn2) , T(A12Mg3Zn3), S(Al2CuMg), O(A12Cu) , A17Cu2Fe, Al13Fe4 and Mg2Si can happen beneath the solidus. The η and T stages were regularly exhibited as strong arrangements with amplified piece ranges containing every one of the four components. The second stages in view of η(MgZn2), (A12Mg3Zn3) and (A1,CuMg) were available in the as cast Al-Zn-Mg-Cu combinations, and the way of these stages was reported.[6]

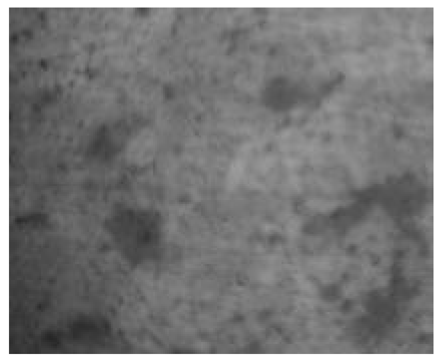
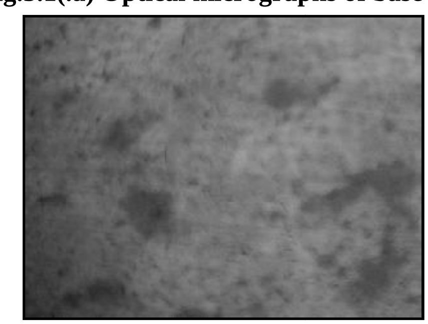


Fig.3.1(.a) Optical micrographs of base metal in



(b) Retrogression and re-ageing conditions

optical micrographs showing grain structure developed in the base AA 7075 aluminium alloy .The surface etching was done with Keller reagent, Micrographs shows elongated pancake shaped grains and equiaxed

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White matrix of α-solid solution dendrites and second phase zinc rich eutectic appearing black in colour. Micrographs revealed that amount of zinc rich eutectic is more in as received condition when compared to that of peak aged (T6) alloy. After T6 heat treatment eutectic becomes fine globular zinc particles, intermetalics, which are uniformly distributed in the matrix. On applying T73 condition we can observe from the microstructure that the distance between the precipitates is still more than T6.

The microstructure developed during retrogression the matrix enriched in zinc and magnesium due to the dissolution encourages the formation of new η′precipitates, while existing η′precipitates grow and transform to η. On the other hand, η precipitates that mainly exist at grain boundaries are coarsened and become more spaced. Similarly for Retrogression and Re-ageing condition in the matrix we can more amount of dissolution of the precipitates and more spaced.

3. 2 Hardness Studies of Base Metals

The hardness values of Base metals in T6 and RRA condition are given in Table 4.1. It is evident from these values that higher hardness values are recorded in peak aged condition which is attributed to the precipitation of zinc rich and magnesium rich eutectics. Higher hardness values are recorded in T6 alloy than in RRA condition of the alloy weld.

During aging, the hardness is largely determined by amount of fine precipitates formed in the alloy; more fine precipitates lead to higher hardness. The increase in hardness in the peak aged condition can be attributed to formation of the coherent and semi-coherent precipitates (MgZn2) and their intermediate precipitates. The hardness increase is mainly due to the lattice strain hardening, caused by the precipitation of coherent and semi coherent precipitates in peak aged condition.

Drop in hardness from peak aged condition to over aged condition is believed to deformation of incoherent precipitates. the over ageing of Al alloys has generally been accepted to start when the intermediate or fully formed precipitates starts to become incoherent with the matrix and increase in size, become less numerous and lose coherency with the matrix the overall effect of this a loss of hardness. This is clearlyevident through the VHN values those were observed at different conditions.

3. 3. Corrosion of Base Metals

The electro chemical behaviour of Al–Zn–Mg–Cu alloys has been investigated by means of potentiodynamic polarization measurements The AA7075 is dependent on the temper condition because the Mg, Zn and Cu content of the matrix changes during solution heat treatment and aging of the alloy [8]. The Al_7Cu_2Fe and $(Al,Cu)_6(Fe,Cu)$ intermetallics are the initiation sites for pitting in Al–Zn–Mg–Cu alloys .The pitting is due to local dissolution of the matrix or to dissolution of the intermetallics because there is galvanic coupling between intermetallics and matrix. The intermetallics containing Cu and Fe are cathodic with respect to the matrix and promote dissolution of the matrix, while Mg-rich intermetallics Are anodic with respect to the matrix and dissolve preferentially.

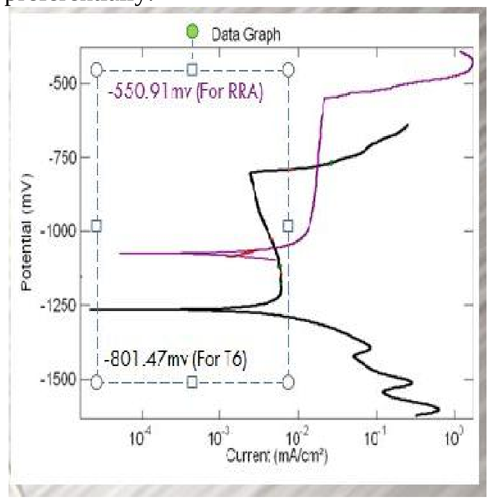

Figure 3.2.**Pitting curves of base metal AA7075 Al alloyT6 and RRA conditions**

3.4 Microstructure of Friction Stir Welds

The weld has a typical FSW appearance, similar to that reported by other authors working on 7XXX .The weld had a central nugget, or dynamically recry stallized zone, corresponding to the location of the pin of welding tool. The optical micrographs of AA7075 nugget zone in various temper conditions is shown in Fig.4.4 (a)-(d)

3.5 Hardness of Friction Stir Welds at Different Zones

Vickers hardness values of AA7075 friction stir welds in T6 and RRA conditions are taken at different location in the welds.

The softening of the weld zone of this material after friction stir welds has been attributed to the least partial dissolution of precipitates responsible for the strength of the material in the weld nugget from the Table 4.3, we can be observed an decrease in hardness in other temper condition due to formation of fine precipitates which are uniformly distributed than T6 temper condition.

3.6. Pitting Corrosion of Friction Stir Welds

The E_{pit} values of NZ, TMAZ and HAZ are discussed. It was clearly noticed that the more positive E_{pit} values are recorded in the NZ, TMAZ and HAZ of the friction stir welds after overaged treatment. Comparatively uniform pitting corrosion resistance was observed throughout the cross section of the weld which shows that overaged treatment resulted in better pitting corrosion resistance.

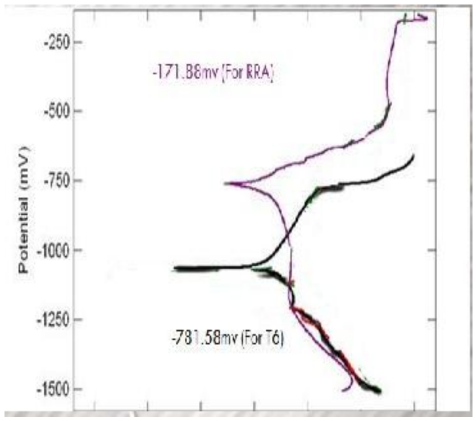

Fig.3.3 Pitting Curves of dynamic polarized Nugget Zone of AA7075 FSW in different temper conditions

Conclusions

Fine grained microstructure has been obtained in the friction stir welding of AA7075 alloy.

Post weld heat treatment of T6 (Peak aging) treatment has improved the mechanical properties of AA7075 friction stir welds with decrease in the pitting corrosion resistance.

Post weld heat treatment of Retrogression and reaging (RRA) treatment has improved the pitting corrosion resistance of friction stir welds of AA7075 with marginal decrease in strength.

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