A review on Microstructure and Corrosion behaviour of RRA Treated 7075 Al alloy"

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ABSTRACT

The alloy used is AA 7075 alloy and is classified under 7xxx series of alloys and major alloying element is zinc. It is strong, with strength comparable to many steels and has good fatigue strength and average machinability, but has less resistance to corrosion than many other Al alloys, to minimize this effect on 7075 alloy I undergone through the investigation, of AA7075 Al alloy subjected to T6 treatment for variables i.e. solution temperature, ageing time, ageing and re-ageing temperature will be observed for microstructure. They will be tested for mechanical properties such as ultimate tensile strength, ductility, hardness. This paper reviews some of the methods which are used for resistance, corrosion and Microstructure of AA (Aluminum alloy)

Keywords – Corrosion, *Microstructure, Alloy, retrogression and reage.*

I. INTRODUCTION

The 7075 aluminum alloy's composition includes 5.1-6.1% zinc, 2.1-2.9% magnesium, 1.2-2.0% copper, and less than half percent of silicon, iron, manganese, titanium, chromium, and other metals. Tests conduct on corrosion by conducted using sodium chloride as corrosive medium to know the effect of heat treatment variables on corrosion rate. All these tests will be conducted as per ASTM norms. The results of the tests will be compared with that of as cast material. The microstructure of as cast and heat treated alloys will be observed and photographed using Light optical microscope to know the changes in morphology of the major alloying element namely Zinc. The corroded surfaces of the alloy specimens will be photographed to know the mechanism of failure.

Researchers have carried out investigations on aluminum and aluminum alloy based composites examining the various aspects involved in their processing metallurgical and mechanical characterization, their suitability for technological applications over a period of time and the information about them are available in published literature.

II. Temperature Effect

Several authors have found that the significant strain rate and temperature dependence of the flow stress of materials such as copper and titanium alloy in the high strain-rate ranges can be understood in connection with the evolution of the structure during deformation. Actually, the mechanical behavior of a material depends not only on the strain rate and temperature but also on its current microstructure, and changes in microstructure result in changes of the plastic flow behavior. Hence, the establishment of more physically-based constitutive models to describe the complex loading processes of 7075 alloy requires knowledge of the coincident in fluencies of temperature, strain rate and microstructure on the high-strain rate mechanical responses of the alloy.

Woei-Shyan Lee et al found that the compressive stress strain response depends sensitively on the applied strain rate and test temperature. Considering the effects of strain rate, temperature, strain hardening, rate sensitivity and thermal softening of the material, a constitutive equation is used successfully to describe the dynamic impact deformation behavior of 7075 Al alloy. Microstructural observations reveal that the size of the initial coarse equi-axial grains is reduced as the strain rate and temperature increase due to dynamic recrystallization. In contrast, the second phase increases in size in response to increasing strain rate and temperature.

They was investigated the influence of the loading rate and the temperature on the mechanical properties and microstructure variations. The compressive stress strain response of this material is found to depend on both the strain rate and the temperature. By means of the experimentally-determined material parameters, a proposed deformation constitutive equation is used successfully to describe the behavior of the material under dynamic loading. In their fracture analysis show that adiabatic shear bands play a key role in the dynamic failure process of 7075 Al alloy. The fractures exhibit relatively smooth surfaces, which contains many cracks that are characteristic of brittle fracture. Microstructural observations reveal that grain refinement and second phase growth are induced during high-rate and high-temperature deformation.

LI Jin-feng et al They investigated the influence of two novel aging treatments, T6I6 (130deg, 80 min + 65 deg, 240 h+130 deg, 18 h) and high-temperature pre-precipitation (HTPP) aging (445 deg, 30 min+120deg, 24 h) on the tensile properties, intergranular corrosion, exfoliation corrosion behaviors and microstructures of 7075 Al alloy was studied, which were compared with the T6, T73 and RRA treatments. Compared with T6 treatment, the RRA, T73, T6I6 and HTPP aging treatments cause the discontinuous distribution of the K precipitates at the grain boundary, which decreases the intergranular corrosion and exfoliation corrosion susceptibility of the alloy. Meanwhile, the T6I6 and RRA treatments can keep the high strength of the 7075 Al alloy, but the studied HTPP aging and T73 treatments lower its strength.
In this they concluded the aging treatment lowers the K precipitate density of the 7075 Al alloy due to the precipitation of some coarse particles during the pre-precipitation process at the temperature of 445 deg.The 7075-T6I6 alloy possesses higher precipitate density and whole precipitate volume fraction within the grain than the 7075-T73 alloy, and its whole precipitate volume fraction is even greater than that of the 7075-T6 alloy, due to the interrupted aging process at a low temperature of 65degree for a much long time of 240 h.

HOLT et al. carried out around twenty RRA heat treatments on pieces of different sizes taken from a C-130 sloping longer. They tried various combinations of heating, cooling methods along with the media. Meeting the basic minimum requirements, they achieved satisfactory strength in the material subjected to RRA treatment, and there was significant improvement in the corrosion resistance of the material in comparison to the original 7075-T6511 condition. The RRA heat treatments were also carried out on new 7075-T6511 extrusions of irregular sections and almost similar results were achieved as compared to the service-exposed material for the same temper.

III. Microstructure Effect

The microstructure of as cast and heat treated alloys will be observed and photographed using Light optical microscope to know the changes in morphology of the major alloying element namely Zinc. The corroded surfaces of the alloy specimens will be photographed to know the mechanism of failure.

Timothy J Harrison et al details an initial study of the differences, if any, in corrosion behaviour between 7075-T6 sheet and 7075-T651 extruded aluminum alloy. The study involved a visual inspection of the grain structure of each material and an analysis of the grain sizes. It was found that there is a significant difference in the grain sizes of the two materials; the extruded material had grains that were approximately 15-20% of the size of the sheet grains. Finally, the grains in the extruded material appeared to form a semi continuous line of grain boundaries, possibly facilitating the growth of laminar intergranular corrosion; the sheet material contained higher-angle grain boundary junctions which should limit the amount of laminar intergranular corrosion produced and promote networked intergranular corrosion. Further testing will involve corroding specimens and investigating the size, shape and depth of the corrosion produced.
The difference found in their study is Important differences between the two materials were found; the extruded material had very small grains that formed a structured, semi-continuous line of grain boundaries. The authors hypothesis that this may have the ability to facilitate laminar intergranular corrosion. The sheet section had larger grain boundaries that did not form a semi-continuous line due to a larger amount of high-angle grain boundary junctions; again, the authors hypothesise that this is less likely to lead to laminar intergranular corrosion, however is more likely to create networked intergranular corrosion. It is therefore concluded that there may be differences in the corrosion behaviour of the two materials, which will have consequences for selecting the best material to assist in modeling corrosion behaviour in the current research program. It will be necessary to investigate the actual differences in corrosion behaviour between the two materials before proceeding to develop a model that will help to predict fatigue-related issues in aircraft components. Such a comparison will provide additional robustness to the modeling. The continuing program will involve corroding specimens of both 7075-T6 sheet and 7075-T651 extrusion and investigating the corrosion found using methods such as optical microscopy, SEM,

ultrasound, eddy current, tomography and further micro hardness testing.

K. RAJAN, et al under gone on heat-treatment procedure providing for enhanced stress-corrosion cracking resistance without any sacrifice of yield strength in 7075 aluminum alloy is investigated using transmission electron microscopy. It is suggested that the heat treatment (known as retrogression and re-ageing) provides for large grain-boundary precipitates and coherent matrix precipitates. The latter provides for the high strength levels while the grain boundary precipitates provide for enhanced stress-corrosion cracking resistance. A hydrogen embrittlement mechanism of stress-corrosion cracking is assigned to this alloy system. The clearly shows the results of the retrogression and re-ageing treatments of 7075 aluminum alloy suggest thatthe traditional trade-off between stress-corrosion cracking resistance and yield strength in choosing between T73 and T6 tempers is unnecessary.

The improvement in stress-corrosion cracking resistance correlates well with the increase in grain-boundary precipitate size. The defect structure associated with the Incoherency of the precipitate/matrix interface can act as trapping sites for hydrogen, where bubbles of gaseous hydrogen can form. Enhancing grain-boundary precipitation is necessary in producing a microstructure resistant to hydrogen embrittlement. Since grain-boundary defects can affect second-phase nucleation, enhancing the mobility of such defects should promote Grain-boundary precipitation. This is an area of further investigation.

J.K. PARK et al shows 0 The microstructures of the commercial 7075 A1 alloy in the peak aged (T651) and overaged (T7) tempers were studied using transmission elect/on microscopy. The microstructure of 7075-T651 is characterized predominantly by the presence of a fine dispersion of the .transition phase; the primarily plate-shaped. Particles have diameters ranging from 3 to 10 nm. The microstructure of the commercial 7075 A1 alloy in the peak-aged (T651) temper contains predominantly the T/' transition phase, with smaller amounts of the T/l type also present. Some of the 7 nm particles are heterogeneously nucleated on dislocation lines. Alloy is believed to arise mainly from the presence of the fine dispersion of small particles, which are most probably coherent.

IV. Retrogression and reage

RRA consist of applying to the alloy in the T6 temper a double stage thermal cycle: the first stage (retrogression) runs at higher temperature and is followed by a stage similar to that used to obtain the T6 temper (re-ageing). The duration of the first higher temperature stage is the necessary for the maximum solution of the T6 precipitates to occur; a minimum mechanical strength is being associated with this temper. During the second lower temperature stage (the reageing treatment) the solute re-precipitates and the mechanical strength increases again

F. Viana et al concentrate on The 7075 aluminium alloy presents a low stress corrosion cracking strength when aged to achieve maximum mechanical strength, T6 temper; high stress corrosion cracking strength is attained with overageing, T7 temper; but with loss of mechanical strength. Retrogression and re-ageing treatments improves the stress corrosion behaviour of the alloy whilst maintaining the mechanical resistance of the T6 temper. The microstructures produced by the retrogression and re-ageing treatments were characterized in this study by transmission electron microscopy, electron diffraction and differential scanning calorimetry. The precipitation is extremely ®ne and distributed homogeneously inside the grains, being slightly denser and more stable than that resulting from the T6 temper; whilst the grain boundary precipitation is quite different from that resulting from T6 treatment, the particles being coarser, and much closer to the precipitation resulting from T7 temper. The retrogression temperature is the main property controlling factor; a higher retrogression temperature, increasing the dissolution degree, promotes the formation of more stable precipitates on re-ageing.

The T6 temper microstructure is characterized by a high Density of fine precipitates distributed homogeneously in the aluminum matrix. The retrogression temperature influences the microstructural stability after re-ageing: the greater the retrogression temperature, the more stable is the microstructures obtained after re-ageing.

Timothy J Harrison R. Clark Jr This paper details an initial study of the differences, if any, in corrosion behaviour between 7075-T6 sheet and 7075-T651 extruded aluminium alloy. The study involved a visual inspection of the grain structure of each material and an analysis of the grain sizes. It was found that there is a significant difference in the grain sizes of the two materials; the extruded material had grains that were approximately 15-20% of the size of the sheet grains. Also, the grains in the sheet material were wider, with a length-to-width aspect ratio of 1.5 (compared with 1.3 for the extruded material).

It is clearly defines the differences in the corrosion behaviour of 7075-T6 sheet and 7075-T651 extrusion, through an analysis of the grain structure. Important differences between the two materials were found; the extruded material had very small grains that formed a structured, semi-continuous line of grain boundaries. The authors hypothesise that this may have the ability to facilitate laminar intergranular corrosion. The sheet section had larger grain boundaries that did not form a semi-continuous line due to a larger amount of high-angle grain boundary junctions; again, the authors hypothesise that this is less likely to lead to laminar intergranular corrosion, however is more likely to create networked intergranular corrosion. It is therefore concluded that there may be differences in the corrosion behaviour of the two materials, which will have consequences for selecting the best material to assist in modelling corrosion behaviour in the current research program. It will be necessary to investigate the actual differences in corrosion behaviour between the two materials before proceeding to develop a model that will help to predict fatigue-related issues in aircraft components. Such a comparison will provide additional robustness to the modelling. The continuing program will involve corroding specimens of both 7075-T6 sheet and 7075-T651 extrusion and investigating the corrosion found using methods such as optical microscopy, SEM, ultrasound, eddy current, tomography and further micro hardness testing.

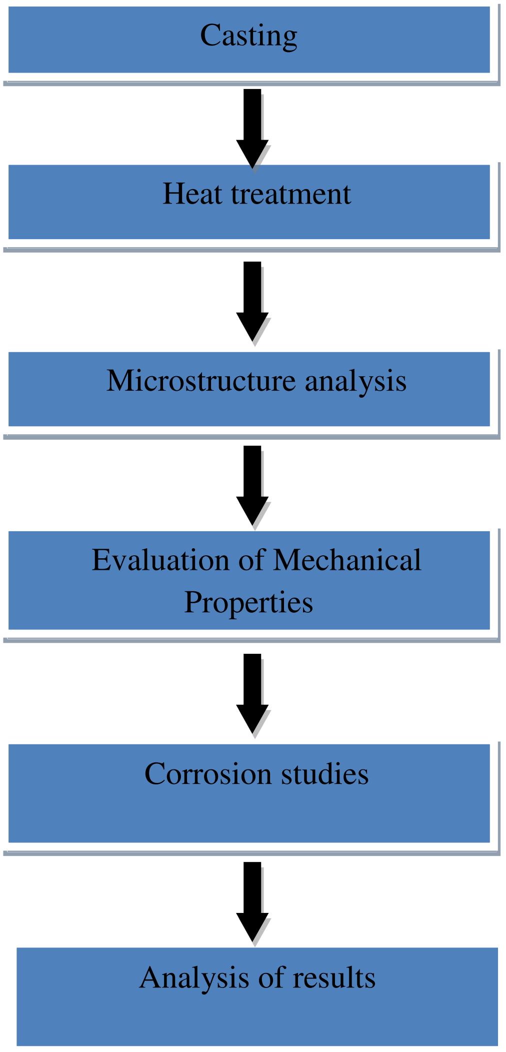
R. Clark Jr et al investigated the influence of varying the thermal processing parameters on the physical and mechanical properties of 7075 T6 aluminum alloy was studied. The variables altered were solution treatment temperatures, quenching media and artificial aging conditions. The influence of varying these parameters on the tensile strength, electrical resistivity and hardness of the alloy is discussed and an excellent correlation is found between the tensile strength and hardness.
The data for the physical and mechanical properties measured for 100 conditions of thermally processed Al 7075 alloy revealed an excellent linear correlation between the hardness and ultimate tensile and yield strength values. Hardness values could be used as a predictor for tensile strength of this alloy. A simple relationship between percent IACS values on the one hand and hardness or tensile strength values on the other could not be found.

V. Appendix

Table: 1 Publications which have used different study methods on this parameters

Sl.no	Parameters	Publication
1	Temperature Effect	LI Jin-feng et al, Woei-Shyan Lee et al, A.K. Ghosh et al, W.S. Lee et al, H. Kobayashi et al,
2	Microstructure Effect	K. RAJAN et al, Timothy J Harrison et al, J.K. PARK et al, J.H. Auld et al, J.K. Park et al,
3	Retrogression And reage	F. Viana et al, R. Clark Jr et al, Timothy J Harrison et al, Green RE et al, Talianker M et al, Liao M et al, Posada M et al, Harlow DG et al,] W. Heppleset al, R. Deiasi et al, J.M. Papazian et al, A. Baldanton et al
4	Grain size , Corrosion	] Heinz A et al, Jones R et al, Wang X et al, Vasudevan AK et al,] Chen X et al, B .M. CINA et al, L. CHRISTODOULOU et al, M. F. ASHBY et al, J.C. SCULLY et al, R. GEST et al,

VI. METHODOLOGY



Flow Chart-1 Methodology

VI. Conclusion

Various methods and techniques used in various publications to understand different aspects posed by the research on the microstructure and corrosion behaviour of Al 7075 alloy. The following points and future scopes can be summarized from this discussion:

1. The physical and mechanical properties for several conditions of thermally processed Al 7075 alloy revealed an excellent linear correlation between hardness and ultimate tensile and yield strength values; this can be used to develop an approach in it.

2. The T6 temper microstructure is characterized by a high density of fine precipitates distributed homogeneously in the aluminum matrix the precipitates essentially being ‘η’ with small amounts of GP zones and ‘η’ being present. Retrogression is responsible for the dissolution of the less stable precipitates (GP zones and the finer particles of ‘η’. inside the grains; the extent of the dissolution process being controlled by the retrogression temperature, the grain boundary precipitates growing and becoming more spaced.

3. The retrogression temperature influences the microstructural stability after re-ageing: the greater the retrogression temperature, the more stable is the microstructures obtained after re-ageing. This will help to do further study in different parameters in it.

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