ENHANCEMENT OF MECHANICAL PROPERTY OF ALUMINUM ALLOY 2024 : An OVERVIEW

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Abstract - *Jobs are being done in the field of mechanical engineering to achieve better results either by alloying, changing grain structure or enhancing the mechanical properties of materials. In the following paper we are trying to enhance the mechanical property and the samples have been tested on tensile test machine, hardness testing machine, XRD analysis, and wear test. Fretting wear test is used to determine the enhanced wear properties. Material selected is aluminum alloy 2024. For hardness test, Vickers hardness test is applied. For change in grain structure optical microscopy is used. After experiments have been done samples came out with high durability and high ductility.*

Keywords *–Aluminum alloy 2024, Fretting wear test, Optical microscopy, Vickers hardness test, XRD analysis.*

I. INTRODUCTION

Aluminum alloy 2024 is Associate in Nursing Al alloy, with copper because the primary alloying component. It's utilized in applications requiring high strength to weight quantitative relation, similarly nearly as good fatigue resistance. It's wieldable solely through friction attachment, and has average machinability. Attributable to poor corrosion resistance, it's usually clad with Al or Al-1Zn for defense, though this might scale back the fatigue strength. In older systems of word, this alloy was named 24ST. 2024 is usually extruded, and conjointly accessible in alclad sheet and plate forms.

It's not normally cast (the connected 2014 Al alloy is, though)

1.1 PROPERTIES OF ALUMINUM:

Aluminum alloy 2024 has a density of 2.78 g/cm^3, electrical conductivity of 30% IACS, young's Modulus of 73 GPa across all temperatures, begins to melt at 500 °C.

1.2 APPLICATIONS:

Due to its high strength and fatigue resistance, 2024 is widely utilized in craft structures, especially wing and body structures beneath tension. Additionally, since the fabric is prone to thermal shock, 2024 is employed in qualification of liquid penetrate tests outside of traditional temperature ranges

1.3 COMPOSITION OF ALLOY:

Aluminum alloy 2024 consists of

*Magnesium – 1.1 to 1.7%

*Silica – 1.2% to 1.9%

*Copper – 3.4% to 4.5%

* Ferrous – 0.4%

*Chromium – 0.1%

* Zinc – 0.2%

* Titanium – 0.17%

* Manganese – o.1% to 1.0%

* Aluminum – Balanced.

II. Literature review:

Saito et al. (1999) [1],
Used commercial aluminum 1100, aluminum alloy 5083 and Ti additional opening free steel (IF steel) for study and experiment of accumulative roll bonding method (ARB). Durability of aluminum alloy1100 at close temperature is exaggerated by 2.6 times of the beginning materials (after eight cycle of arbitrager it reaches 304Mpa; at first 84Mpa). Durability of IF steel at close temperature is enhanced by seventy two times of the beginning materials (after eight cycle of arbitrager it reaches 551Mpa; at first 319Mpa). Durability of aluminum alloy 5083 at close temperature is exaggerated by 1.72 times of the beginning materials (after eight cycle of arb it reaches 751Mpa; at first 274Mpa.). Elongation decreases by 8 %, 6 % and 6 % once eight cycles of arb in aluminum alloy 1100, aluminum alloy 5083and IF steel severally.

Y. Saito (1999)[2],
Ultra fine grained structure is seen after five cycles. This shows that as the number of pass or cycle increases the micro structure of rolled material is converted into ultra fine grains.TEM micrographs of several cycles are taken to evaluate the microstructure. The associated selected area diffraction patterns taken from the center of the field by use of an aperture (1.8 mm in diameter). The SAD patterns have various reflections along circles. Such patterns indicate that

large disorientation exists between individual grains. Therefore it is clear that an ultra fine grain structure exist with large disorientation. The change in microstructure of IF steel after each pass is observed by TEM. The selected area diffraction patterns were taken from the center of the bright field images using an aperture with a diameter of 1.6 mm.

S.H.Lee (2001)[3],

material used aluminum alloy 6061 for experiment to study the ARB process. The ARB process is done at ambient temperature without lubricant. To find mechanical properties before and after ARB process; rolling process is done up to eight cycle. He did the mechanical test on Instron-type tensile testing machine at surrounding temperature. Tensile strength of specimen after eight cycle is increased by 3 times (after 6 cycle 363Mpa; initially 120Mpa) which is greater than T6 treated 6061 aluminum alloy (tensile strength of T6 treated 6061 aluminum alloy having 310Mpa.). Tensile strength of aluminum 6061 alloy after severe plastic deformation (ARB) is increases without heat treatment; Change in hardness is measured by Vickers hardness test through the thickness of specimen before and after one, three, and five ARB cycle. The hardness of specimen shows constant value before ARB. However, after ARB process shows in-homogeneous distribution of hardness in the thickness direction; having higher values near the surface and center. The high value of hardness near the surface is caused by work hardening due to large redundant shear strain induced by high friction between roll surface and specimen during the ARB.

N. Tsuji (2002)[4]

Micro structural change of ultrafine-grained aluminum during high speed plastic deformation. The material used is aluminum 1100 alloy sheets. Sheets subjected to six ARB cycles showed identical ultrafine-grained microstructure. As result the ARB processed sheet was uniformly filled with UFGs elongated along rolling direction (RD). Selected area diffraction (SAD) taken by use of an aperture of 1.6 mm diameter reveals a ring-like pattern, which indicates the existence of various orientations within small area. Micro structural change during deformation of ultrafine-grained aluminum (1100) was studied at various strain rates ranging from 2 to 60000 s_1. Sheets of 1100 aluminum processed by six cycles of ARB (equivalent strain of 4.8) were filled with pancake shaped ultrafine grains surrounded by high-angle grain boundaries. The results also clarified that large deformation at very high strain rate could produce finer grain subdivisions, because lateral grain size in the specimens impact compressed to more than 75% reduction was much smaller than that geometrically expected.

V. Rajinikanth (2007)[5]

Effect of repetitive corrugation and straightening on Al and Al–0.25Sc alloy. Material taken was Commercial pure aluminum (CPAl) with minor impurities of 0.16 wt.% Fe, 0.14 wt.%Si and Al–2Sc master alloys. A basic RCS cycle consists of two steps via: bending and straightening, rotation of 90° between successive passes and to prepare a correlative die with multiple teeth in order to introduce significant shear train into the sample during the corrugation and thereby increase the product yield. Came up with result that rotation of sample by 90° between successive passes is important to obtain better grain refinement by using RCS technique and hence responsible for higher hardness values. The hardness levels achieved after 4RCS passes in the case of CPAl as well as Al–Sc alloy as compared to the conventional rolling process.

Hiromoto Kitahara (2007)[6]

the authors used commercial purity titanium sheet for his study and experiment. he did rolling of Ti sheet with initial dimension ; thickness 2mm, width 25mm,and length 150mm.Rolling is done with 50% reduction and equivalent strain 4.8. Authors estimate the fatigue crack growth and stress intensity factor. They used compact tension specimen for fatigue test. Fatigue crack growth test was carried out according to ASTM E647 by Electro servo hydraulic fatigue testing machine operated at10 Hz frequency at room temperature. Fatigue crack growth rate decreases with increase in number of cycle. Tensile strength increases with increase in strain.

Sabirov, Ilchat (2008)[7]

The microstructure evolution and mechanical properties of cryorolled Al alloys. A solutionized Al2024 alloy was subjected for rolling (Cryorolling) at liquid nitrogen temperature resulting in an ultra-fine Structure. The material was also subjected for recovery annealing at 160°C. The ultrafine structured material established increased strength but very low ductility. An Al2024 alloy with an ultra-fine structure was successfully composed via Cryorolling. The material had higher yield strength of 550 MPa, but a very low ductility, ~2.2 %.

Ramesha Gowda, Yellappa M, Manu G (2015)[8]

Evaluation of Hardness and Wear properties of Al2024. Al2024 is used as matrix material due to its properties. Test was done to find out hardness and wear properties. Increasing the % of Alumina the hardness of the composite material increases. With increase in Alumina particle size the hardness of composite material decreases. With increase in alumina composition wear rate decreases. With increase in alumina particle size wear rate increases.

III. Conclusion

From all the applied tests over samples hence we can say that by changing the composition according to the requirement we can achieve the phenomenal results. The processes took place was time taking, solution treatment at 520degree Celsius, and quenching changed the grain size of the sample and the changes leads to a higher durability.

By enhancing the composition of silica in alloy

And going through RCS cycle we can obtain a better grain structure and get higher durability.

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