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CONSEQUENCE ON PROPERTIES OF DEEP CRYOGENICALLY TREATED AS-CAST ALUMINIUM ALLOY

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ABSTRACT:- ***Cryogenic technique has happen to a widely used heat treatment practice for multiple products counting in cutting tools, automobile braking, engine components and aerospace industries. All these sectors at all era desires the materials in condition of light in weight but stronger than viable supplies. This prerequisite is pleased through the preamble of composites. Our work is headed for spotlight on the upshot of profound Cryo treatment on characterizing metallurgical and mechanical property of as-cast aluminum alloy at -196*℃ *for different time durations of 24 hours, 37.5 hours and 60 hours. After the profound Cryo conduct of as-cast alloy in liquid nitrogen, the metallurgy of samples showed the transformation in division of precipitate. The modification of microstructure of as-cast aluminium alloy due to cryogenic treatment showed considerable progress in mechanical properties.***

Keywords: AA6061, Cryo treatment, Metallurgy, Mechanical properties, Stir Casting.

1. INTRODUCTION

Metal matrix composites are widely used for specific applications because of their enhanced properties. Composite production may be a liquid state or solid state processing. In liquid state composites fabrication is mostly preferred by the stir casting method. [1] AA1100/Al3Ni composite was produced by in-situ in stir and squeeze castings. XRD, UTS, Wear rate were compared for these methods of casting. The result claimed that reinforcement improved the properties and the most effective process of doing the composite by comparing these two was squeeze casting. For solid state processing friction stir processing [5-6] is used as the same principal followed by FSW [2-4].

Cryogenic, a low temperature heat treatment technique typically creation of greater than -196°C and soaking for a defined period of time where by materials and components are subjected to the aim of enhancing their performance by causing permanent micro structural changes and to remove residual stresses. Cryo treated non-iron materials reveal higher wear, corrosion resistance and toughness as it creates dense molecular configuration ensuing in a superior contact exterior area that reduces friction and wear. Aerospace materials like aluminum and magnesium alloys and space applications, alloys of titanium have been widely tested at cryogenic temperatures, usually by direct immersion in liquid nitrogen. [7] This work presents the comparative study of low carbon steel first layered with Aluminium oxide by PVD route and second one is heat treating the low carbon steel by carburizing process. Comparative study of wear opposition of both heat treated and PVD coated are studied using pin-on-disk wear tester.

[8] Aluminium based oxide armored composite coatings were formed on magnesium plates by cold spray technique. Results showed that strength of coating at interface were found to be better and also it had higher corrosion resistance in mutually on salt spray and electrochemical tests. [9] This work focused on the Cryo behavior in metallurgy and hardness of Aluminium alloy 6061 with aluminium oxide particulate MMC at -196 °C for different duration. The XRD clearly specified, as Cryo action altered the diffraction peak strength of crystals. The influence of dissimilar progression parameters on metallurgy and hardness of AA6061 were differentiated. [10] Durability of AA2014 and AA6061 composed with 15 % of Al_2O_3 particles were considered in the temperature array from −150 °C to 300 °C. Microscopy confirmed those voids were started due to reinforcements rupture at low down temperatures.
Although many researchers were functioning on consequence of Cryo treatment on characterization of MMC, still very little work is payed attention on the outcome of Cryo conduct in as-cast alloys.

2. EXPERIMENTAL INVESTIGATION

The intended compositions of AA6061 are alienated as requisite weight percentage and placed in the crucible for melting to liquid state. The metals are maintained 2 to 3 hrs in the furnace to bring the metals into liquid state and melted above 700 degree Celsius and it is stirred out at 850 Rpm for mixing together. The stirred molten metal liquids are poured into the pattern to our required shape of rod and plate as required dimensions as in Figure 1a & 1b.

Figure 1a & 1b prepared as-cast aluminium alloy.

In this process, liquid nitrogen is supplied into a thermally insulated tank containing these prepared materials which is done in Hosur industry at -196℃ for different time durations of 24 hours, 37.5 hours and 60 hours as in Figure 2.

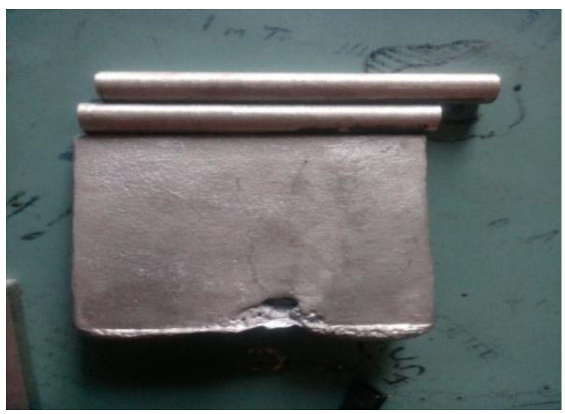

Figure: 2 Cryo treated samples.

3. RESULTS and DISCUSSIONS

The results of Ultimate Tensile Strength (UTS), Brinell Hardness (Brinell Hardness Tester), and Microstructure (Optical Microscopy) of both as cast and deep cryogenic treated as-cast aluminium alloy are given in the following Table 1,2,3,4,5,6,7,8.

TENSILE TEST:

Table No: 1 **As-cast aluminum alloy.**

Test Parameters	Observed Values
Ultimate Tensile Strength (MPa)	95.86
% Elongation 4D GL	2.0

Table No: 2 **As-cast aluminum alloy Cryogenic treated for 24hrs.**

Test Parameters	Observed Values
Ultimate Tensile Strength (MPa)	109.1
% Elongation 4D GL	1.2

Table No: 3 **As-cast aluminum alloy Cryogenic treated for 37.5hrs.**

Test Parameters	Observed Values
Ultimate Tensile Strength (MPa)	107.83
% Elongation 4D GL	1.40

Table No: 4 **As-cast aluminum alloy Cryogenic treated for 60hrs.**

Test Parameters	Observed Values
Ultimate Tensile Strength (MPa)	45.17
% Elongation 4D GL	1.80

Low temperature Cryo-treatment tends to enhance the ultimate tensile stress significantly. Cryogenic treatment made matrix to be hardened and also removed internal residual stresses, allowing easier movement of dislocation in grain structures. UTS is increased in 24 hours cryogenic conduct, but auxiliary cryogenic process is not greatly effectual because of decreased ultimate tensile stress owing to diffusion.

HARDNESS TEST

Brinell hardness is increased up to the cryogenic treated samples of 24 hours. Furthermore it gets decreased because of the coarse grain structure.

Table No: 5 **As-cast aluminum alloys.**

Location	**Observed value in HBW(5mm/250kg)**
Surface 1	91.2
Surface 2	89.2
Surface 3	88.7
Average	**89.7**

Table No: 6 **As-cast aluminum alloy Cryogenic treated for 24hrs.**

Location	**Observed value in HBW(5mm/250kg)**
Surface 1	91.8
Surface 2	91.2
Surface 3	92.8
Average	**91.93**

Table No: 7 **As-cast aluminum alloy Cryogenic treated for 37.5hrs.**

Location	**Observed value in HBW(5mm/250kg)**
Surface 1	77.9
Surface 2	77.1
Surface 3	78.3
Average	**77.7**

Table No: 8 **As-cast aluminum alloy Cryogenic treated for 60hrs.**

Location	**Observed value in HBW(5mm/250kg)**
Surface 1	84.9
Surface 2	86.8
Surface 3	83.9
Average	**85.2**

MICROSTRUCTURE

The Microstructure examinations were made with the magnification of 100X & 200 X and the Etchant used was 0.5% HF. The microstructures of cut section of specimen revealed needles of Iron silicon Aluminium intermetallic phase and also observed needles of silicon-eutectic particles in the matrix. Observed large number of pores in the matrix as in Figure 3,4,5,6.

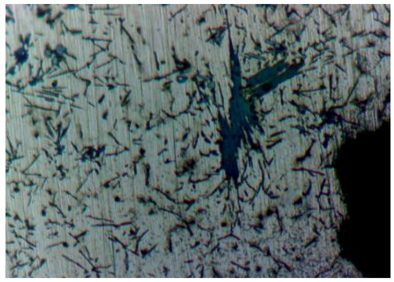

Figure No: 3 **As-cast aluminum alloys.**

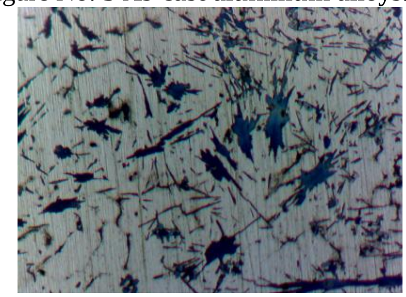

Figure No: 4 **As-cast aluminium alloy Cryogenic treated for 24hrs.**

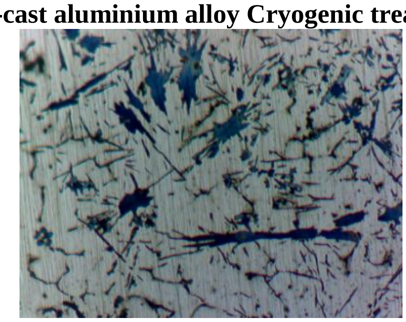

Figure No: 5 **As-cast aluminium alloy Cryogenic treated for 37.5hrs.**

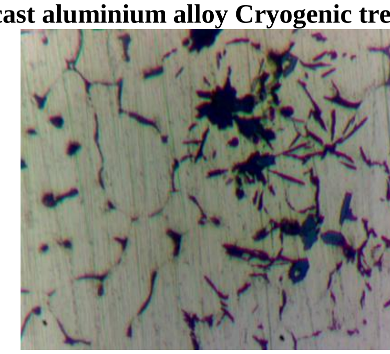

Figure No: 6 **As-cast aluminium alloy Cryogenic treated for 60hrs.**

4. CONCLUSIONS

The mechanical characterization like ultimate tensile strength and hardness is improved for produced as-cast aluminum alloy. Metallurgical characterizations shows denser grain structure as it is deeply cryogenated. For different time duration of deeply cryogenic treatment the 24 hours specimen is giving the best result in both mechanical and metallurgical properties and hence this materials can be used in replacing many other for different applications.

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