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ENHANCEMENT OF MECHANICAL PROPERTY OF ALUMINUM ALLOY 2024: A PROPOSED

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Abstract - *To obtain great strength we need to change the grain size and this paper consist of the work and experiment data which were done by us. By changing the grain structure we can increase the yield strength and tensile strength. There is an inverse relationship between yield strength and grain size which can be better explained by the Hall-Petch equation. Primarily focusing towards the increment in strength and post to that wear also. Hardness test will be done on Vickers micro hardness test machine. For the images of changed grain structure, we have optical microscopy and for phase consideration we did XRD analysis.*

Keywords – Grain Structure, Grain size, Hall-Petch Equation, Vickers hardness test, XRD analysis, Yield Strength

I INTRODUCTION

In the favor of obtaining strength in material we need to perform some process of severe plastic deformation process. There are various processes in SPD but we are referring to Room Temperature Rolling. Basically Room temperature rolling is a conventional method of rolling which is very efficient. It provided us with the phenomenal results. Many things came in the way but the samples are being compared on the basis of heat treatment and 40% room temperature rolled. The sample is being kept under the optical micro scope to observe the refinement of grain structure. Now the material Aluminum alloy 2024 was selected on the basis of its application and properties of its high strength and fatigue resistance. Various industries like automobile and marine industries use this material.

The process of refinement consists of solution treatment and room temperature rolling. The reduction of thickness was 40% because post to that cracks were witnessed and at 60% thickness reduction the sample was totally fractured.

II EXPERIMENTAL PROCEDURE

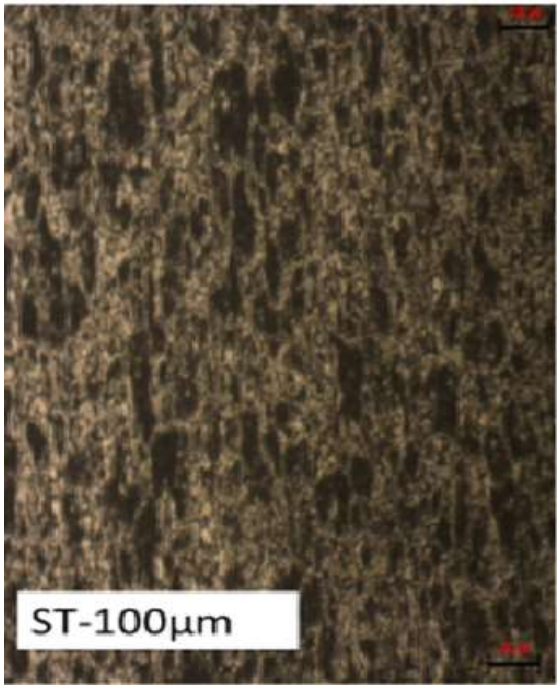
All the required element for the composition of alloy were taken and formed aluminum alloy 2024 with balanced aluminum composition. For solution treatment oven was preheated and then the material kept and proceeded to 520 °C. Then it went through quenching and then cold air. Now, the sample was prepared of size 10mm (length) x 10mm (breadth) x 5mm (height). The sample made was cuboids in shape. Samples prepared were hosted in rolling. The type of rolling used is room temperature rolling and this rolling changes the grain structure and provide better structure which further provide more strength and durability to the alloy. Then after that more rolling was provided and polishing of samples was done. More rolling was applied over samples for refinement of the grain structure. Hence the structure turned into ultra fine grain structure which basically provides the major strength. The first test we formed was Vickers hardness test where the results were phenomenal. Micro-Vickers hardness test was done on Qualities QV-10000 DM hardness machine system. Hardness test were done according to ASTM E384. Hardness test was performed at load of 5gram and dwell time of 10sec.

Indent on hardness sample Solution Treated and 40%Room temperature rolling respectively. Causing this type of indent on the sample which cannot be seen by the naked eyes.

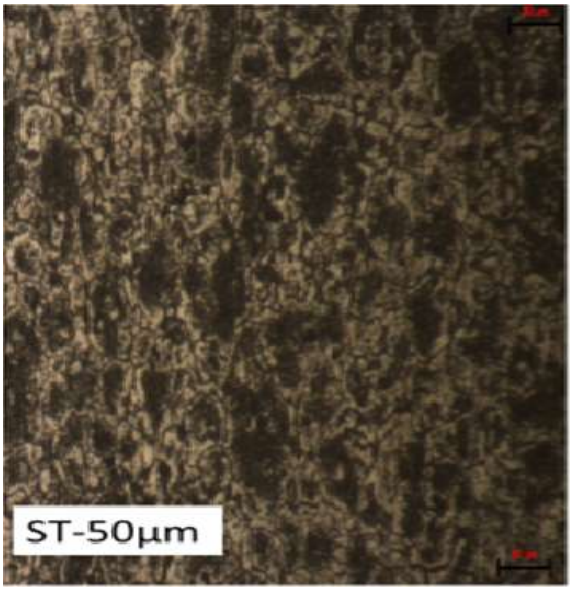
Optical microscopy was applied for the viewing of the refinement of the grain in the material. Optical microscopy also observed the strained grain.

Optical microscopy was done Axioskop2 and use Zen software to take optical image. In this image were taken at 20 x, 10 x and 5 x. To find the grain size by using the image software

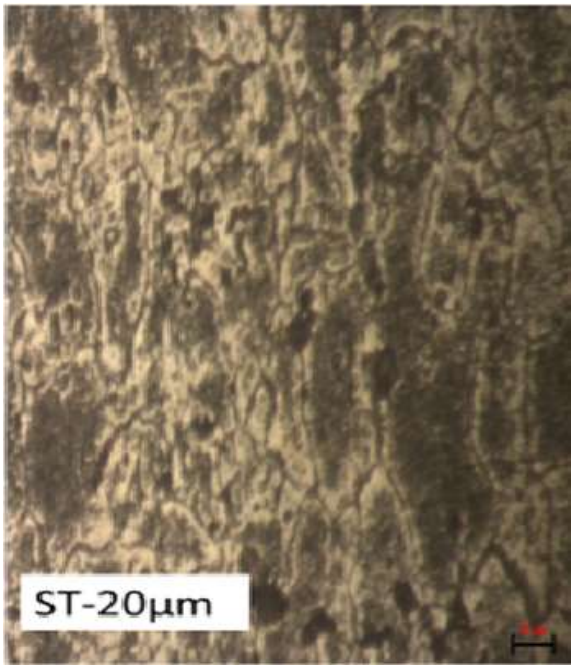
Specimen	Grain Size
Solution Treated	49um
Room Temperature Rolled	860nm



After solution treatment



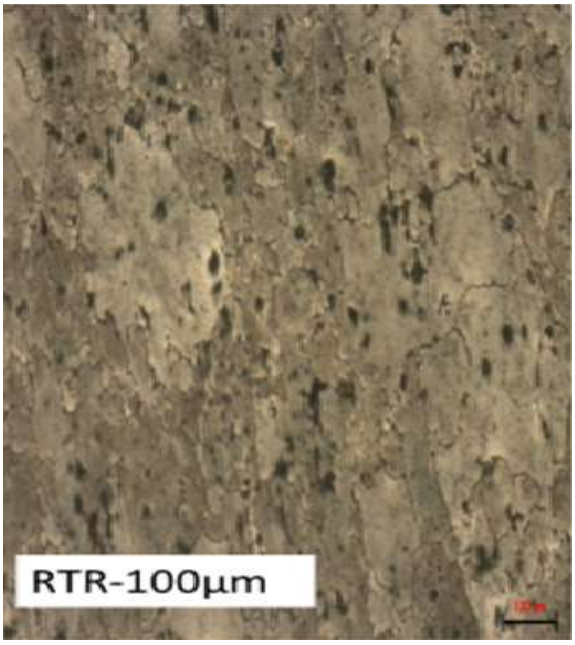
After solution treatment

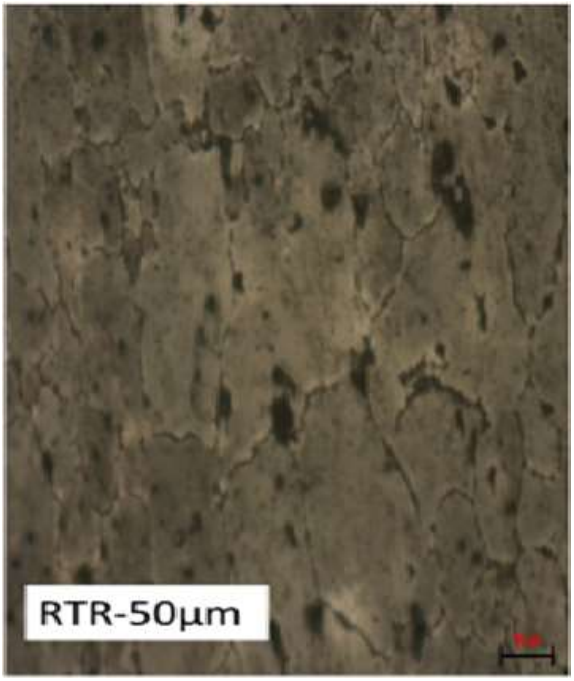


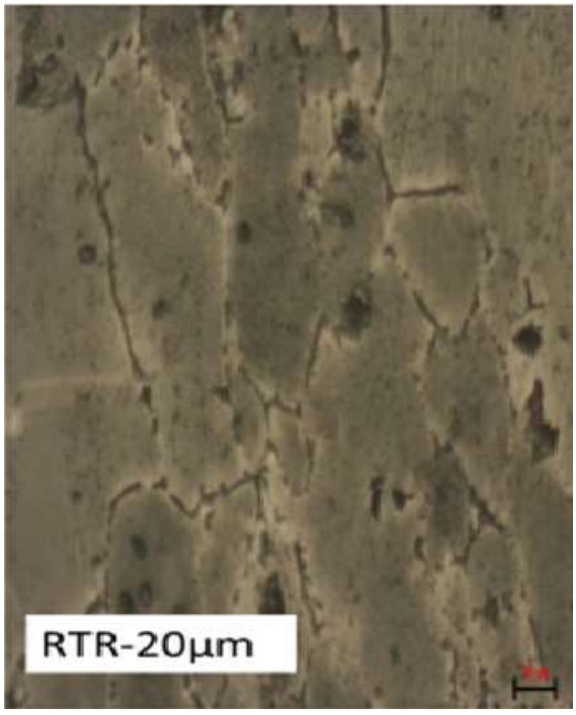
After solution treatment

III Results

As a result we saw that the hardness of the sample increases which was measured by Vickers hardness test. And also the production of Ultra-Fine Grain (UFG) can be observed with help of optical microscope.







SERIAL NO.	SOLUTION TREATED	ROOM TEMP. ROLLED
1	96	139
2	89	142
3	88	148
4	94	143
5	95	140
6	96	145
7	98	139
8	103	149
Avg.VHN	95.37	143.125
In MPa	935.3	1404

Above presented table is the result of hardness test after solution treatment and after room temperature rolling.

SPECIMEN	GRAIN SIZE
Solution treated(ST)	49µm
Room temperature rolled (RTR)	860nm

Above mentioned table contain the data of grain size from micrometer to nanometer.

S.No.	Material condition	2θ(deg.)	FWHM (β)	Crystalline size(nm)
1.	ST Al 2024	37.535	0.256	440µm
2.	40% RTR Al 2024	38.339	0.188	59.83nm

Above mentioned table contains the data of crystal size and phase.

Conclusion

- With increase in normal load, surface asperities equilibrate with loading ball, and rapidly achieve steady

state. Therefore mean COF decreases with increase in normal load.

- With increase in normal load room temperature rolled sample showed best performance at fixed stroke length of 100µm, frequency of 5 Hz and 10000 cycles. Therefore, room temperature rolled sample is better suited for high load application.

- With the change in grain size the hardness of material also increases.

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