

Investigate wear resistance of aluminium 2024 alloy by using pin on disc tribometer

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Abstract - The microstructure of a metal may be very significantly changed by subjecting the material to serve plastic deformation (SPD) and by using Pin on Disk Tribometer SPD lead to a substantial refinement in the grain size to the sub micrometer or even the nanometer range. This Experiment were conducted on high purity aluminum alloy 2024 investigate the wear resistance of severely plastic deformed Al 2024 alloy using Pin on Disc Tribometer. In this initially Al 2024 alloy is solution treated at 520° C and followed by mechanical testing (such as tensile, micro Vickers hardness), characterization techniques (such as x ray diffraction) and then wear testing by the help of pin on disc tribometer results are described showing this potential for using this approach in superplastic forming applications at high strain rates

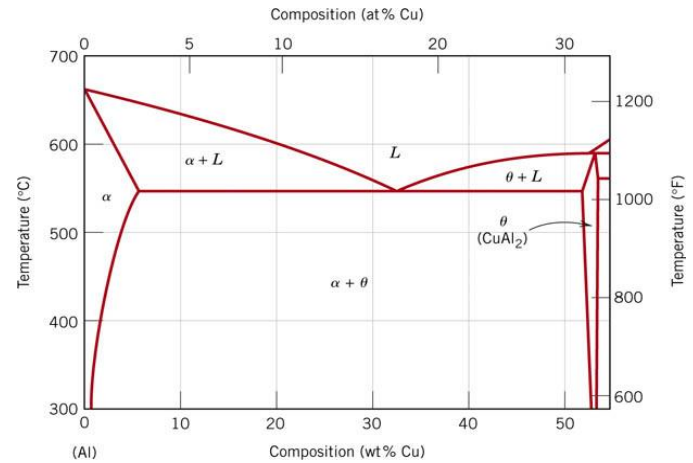


FIG 1 Phase diagram of Al 2024

Key Words: Aluminium Alloy 2024, Solution Heat Treatment, Pin on Disc, Wear resistance, SPD.

1. INTRODUCTION

Aluminum alloy 2024 is an age hardening and is strengthened during the heat treatment process. The alloy is heated at 493°C (920°F) and then quenched for 10 h at 190°C (370°F) and finally cooled air. The condition is obtained when this alloy is heated at 493°C followed by cold water quenched and finally aging at room temperature. After this process metal to change their micro structure and to bring out the physical and mechanical characteristics that make metal more desirable. The size of samples 1cm diameter and 5 cm long. These samples are obtained rolling process and optical microscopy and then process of pin on disc.

1.1 Processes and Equipment's

The heating of an alloy to a suitable temperature, holding it at that temperature long enough to cause one or more constituents to enter into a solid solution. In the case of Al2024, the major alloy element is copper, and by taking the part to 520°C for 8 hours. The copper present within the 2024 will dissolve or disperse uniformly throughout the solid aluminum part.

After solution treated material were rolled by simple rolling machine, with rolling speed 8 RPM and roller diameter 110 mm, Rolled sample having 40% thickness reduction. in this sample performed multiple rolling were done. after rolling done some testing such as Micro hardness test for mechanical testing, optical microscopy and X-RAY diffraction for microstructural characterization

Micro-vickers hardness test

Micro-vickers hardness test was done on Qualitest QV-10000 DM hardness machine system, test were done according to ASTM E384, using diamond indenter with indent diameter 20um. It performed at load of 5 gram and dwell time of 10 sec.



FIG 2 Indent on hardness sample Solution Treated and 40%Room temperature rolling respectively.

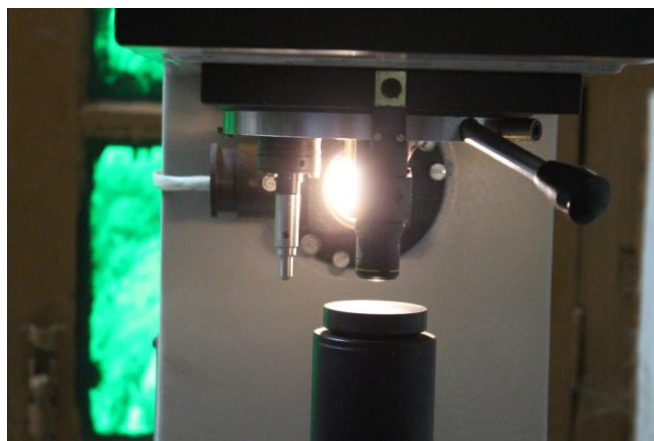


FIG 3 Micro Hardness Test

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



FIG 4 Optical Microscopy

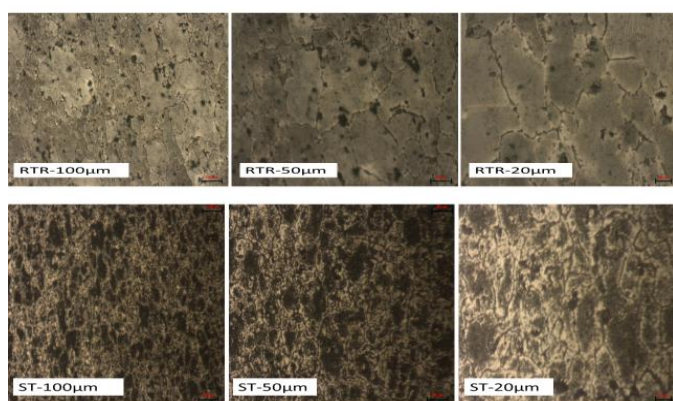
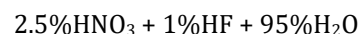


FIG 5 Optical Microscopy after solution treatment and after room temperature rolling respectively.

XRD is an analytical technique design to provide more in depth information about crystalline compounds and measure thickness of thin films and multilayers to determine atomic arrangement before the XRD analysis we need to prepare the sample. In this case Sample preparation Al-alloy

is polished with SiC paper uptown 2000 grid size (kerosene) and then polished with aluminium oxide powder.

After that it is etched by Keller's Reagent



1.2 WEAR TESTING OF PIN ON DISC TRIBOMETER

The pin on disc configuration is commonly used for wear test in laboratories Because of its simple arrangement. However some phenomena which affect the test results markedly are always overlooked. The ASTM code for this method is G99.

Wear testing of Pin on disc Tribometer

Test Procedure

Steps to be followed in order to conduct the experiment are:-

- Place the test metal disc on DC motor.
- Place the pin over the disc.
- Run the motor at full speed and ON the range meter.
- Place the weights in the pan and observe the wear pattern on disc made by pin.
- Measure the radius of wear circle made by pin on the disc.
- Take the highest value of depth of penetration.

2. CALCULATION

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

Table 1 VHN no. w.r.t. Solution Treatment And Room Temperature Rolling

S.No.-	Al 2024 alloy at different condition	2θ (deg.)	FWHM (β)	Crystalline Size
1.	Solution Treated	39.145	0.289	443 μm
2.	40% room temperature rolled	38.942	0.207	61.973 nm

Table 2 Crystalline Size of the Al 2024 at both condition from XRD

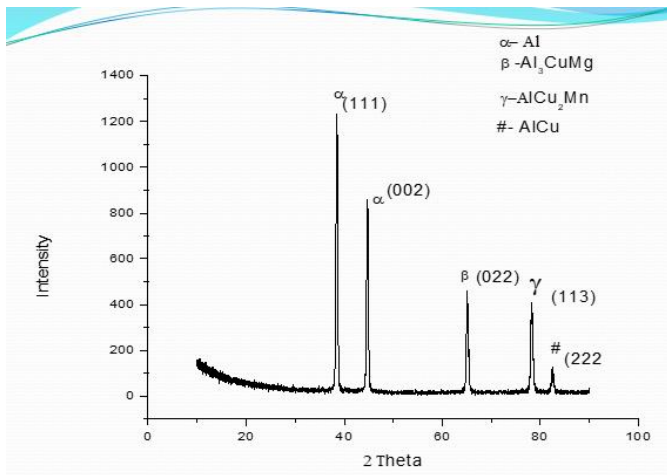


FIG 6 XRD image of Al 2024 40% room temperature rolled

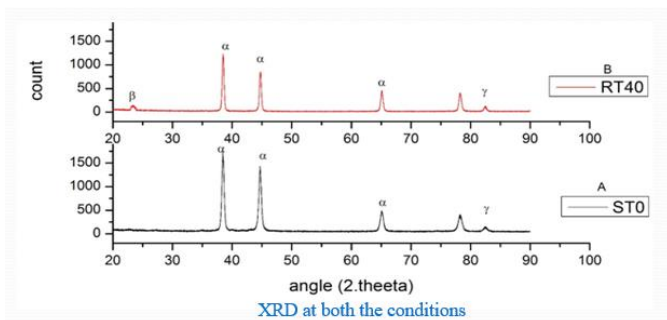


FIG 7 XRD at both the conditions

S.NO	APPLIED LOAD	SPECIFIC WEAR RATE (K)*0.001
01	100g	0.110
02	200g	0.147
03	300g	0.112
04	400g	0.084

Table 3 Specific wear rate of solution treated Aluminum

S.NO	APPLIED LOAD	SPECIFIC WEAR RATE (K)*0.001
01	100g	0.100
02	200g	0.115
03	300g	0.113
04	400g	0.076

Table 4 Specific wear rate of room temperature rolled Aluminum

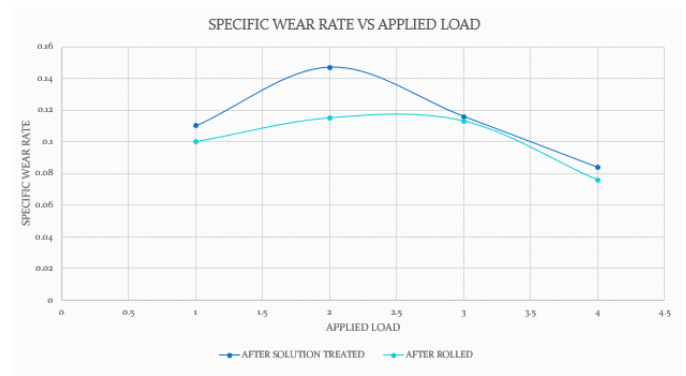


FIG 8 SPECIFIC WEAR RATE VS APPLIED LOAD

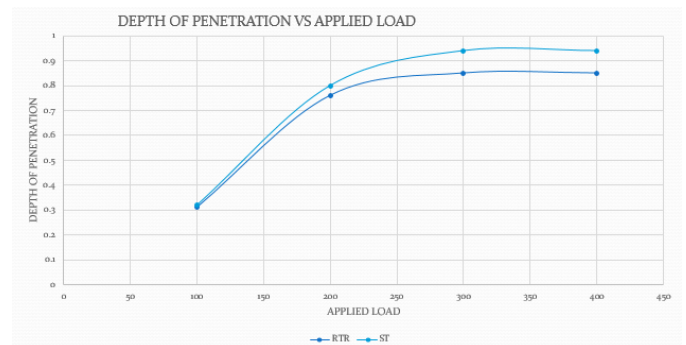


FIG 9 DEPTH OF PENETRATION VS APPLIED LOAD

3. CONCLUSIONS

The optical microscopy considered ultra fine grain structure. The tensile strength increase. The result was observed that friction and wear resistance depended on the sliding velocity. The main evidence was seen by constricting the wear, friction and dynamic response at 0.25 m/s at this velocity. The energy level increase with acceleration. The result is increase hardness, material strength and wear resistance.

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