Effect of Copper Addition on Mechanical Properties of Aluminum pure

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Abstract

In this study, addition of Cu and heat treatment process used to improve mechanical properties of Al pure 3, 4, and 5 wt.% of Cu added into Al ingot separately, to produce Al alloys with deferent ratio of Cu, followed by treated at 500 °C then quench into water. The results showed that addition of Cu and heattrement process led to improve mechanical properties as the hardness values increase as the ratio of Cu increased, where it measured around 45 HB compared with 12 HB for base alloy. Furthermore, the tensile properties of treated alloys improved as the ultimate tensile strength values were 77.18, 85.32, 108.03, 233.37 N/mm^2 for untreated alloy, 3, 4, and 5 wt.% of Cu respectively.

Key words: Mechanical properties; Metal; Heat treatment; Hardness

1. Introduction

The outstanding combination of properties of the Aluminum and its alloy gave a huge industrial significant [1]. Aluminum and its alloy have lots of properties such as good electrical conductive, also good corrosion resistance, thermal conductive and desirable appearance etc. [2,3]. The Aluminum properties let to the association of aluminum alloys with electrical transmission lines and in general all types of transportation [4]. The aluminum as basic raw material is playing a role in automobile and automotive industries, sometimes suffers from severe dangers regardless of its corrosion resistance when it has attack from the media [5]. The demand of aluminum sheets in automobile and automotive industries increases every day, because of its advantages and the materials research is directed at design of smaller and lighter components so as to reduce fuel consumption and running cost though not at the

expenses of quality such as tensile strength and hardness. [6]. Aluminum and its alloys are always light in weight and provide alternative to steel sheet in structural panel applications [6, 7].

Copper and its alloy have been known with their moderate hardness, ductility, toughness and high electrical conductivity, machinability and corrosion resistance. Their high surface area to volume ratio has reduced their use from overhead wire. However, they are used as alloy for architectural application, bio fueling resistance, electrical housing wiring etc. The toxicity of copper on aquatic bacterial and algae has contributed to the use of copper in alloy development for undersea application. Copper has found in use most both as parent metal and alloying element in the development of alloy materials for various engineering applications [8].

2. Experimental procedure

3.1. Material

The test is done to check the chemical composition of the metal through chemical analysis that summed up his idea in effecting Tyne in metal by electrical and gas, test reading shows the percentage of all elements involved in the installation of metal see table 1.

Table 1: Chemical composition of the sample

Eiement	Al	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ni	Ti	Be
Ratio,wt%	99.3	0.07	0.29	0.0002	0.0003	0.0005	0.081	0.001	0.0003	0.026	0.0001

3.2. Sample preparation

Phase 1:

Firstly started by processing the furnace and then rising the temperature up to around 800° c . The sample of 2 kg of Aluminum took about an hour until melting process done, then the Copper was added to the Aluminum by different ratios see table 2 and it were as follows:

Alloy 1: 2 kg pure Aluminum only

Alloy 2: 2 kg aluminum + 60 g copper

And the equation as follows:

60/2000 = 0.03 * 100 = 3%

Alloy 3: 2 kg aluminum + 80 g copper

And the equation as follows:

80/2000 = 0.04 * 100 = 4%

Alloy 4: 2 kg aluminum + 100 g copper

And the equation as follows:

100/2000 = 0.05 * 100 = 5%

Table 2: The percentage of copper in alloy

Alloy	1	2	3	4
Ratio of cu , wt. %,	0%	3%	4%	5%

Phase 2:

In this phase rigged the mold and assemble it, then roasted the template inside the oven done at the temperature of 800° c for half an hour. After it was fully aluminum smelting process take out the template from oven roasting, then after pour molten within the template through open casting relatively slowly to avoid dangers pour metal outside the template even filled up the template, then leave to cool naturally cooled at room temperature within 24 hours. The same process will be repeated for each alloy. Lastly all the samples will be ready to test (Tensile test - impact test - hardens test).

3. Results and discussion

4.1 Hardness Test

Measuring hardness by heat treatment was done by Brinell hardness using the data of effect with 10 mm Dim and carried of 250 kilograms see table 3 for more details.

Table 3: The hardness test results for samples

Sample number	Copper wt. %	Brinal hardens number
1	0 %	12.0
2	3 %	22.9
3	4 %	33.6
4	5 %	45.6

4.2 Heat Treatment

Heat treatment process has been done by placing the samples inside the oven at a temperature of 500°c for two hours long, then the cooling process was suddenly done at the room temperature. This type of heat treatment is called (timer), see figure 1 for more clarifications.

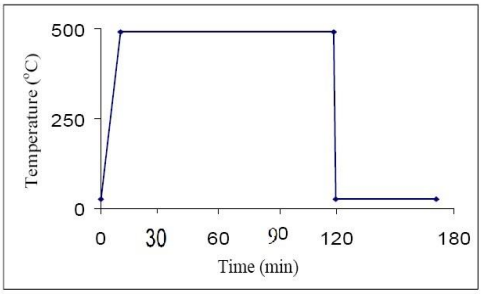

Figure 1: Quench hardening

All the samples put again inside the oven at the temperature of 200° c for 10 hours long and left it to be cooled slowly inside the oven, this process is called (annealing). The main purpose of using this process is to remove internal stresses of metal, see the figure 2.

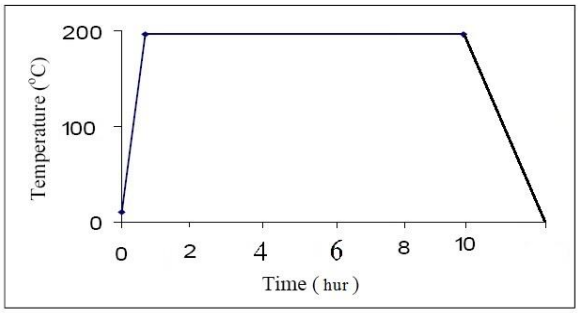

Figure 2: Annealing process

4.3 Tensile Test

Tensile test is one of the most important mechanical tests conducted on different materials. Therefore, engineering applications use the appropriate material selection tensile properties. Tensile properties of the main permanent attributes included in the standard specifications for materials. Tests on the samples and the results are as shown in the following table 4.

Table 4: the tensile test results

Sample number	Copper %	Tensile point N/mm^2	Yield strength N/mm^2	Ultimate Tensile strength , N/mm^2
1	0%	37.46	40	77.18
2	3%	47.26	57	85.32
3	4%	93.31	80	108.03
4	5%	229.70	143	233.37

4. Conclusion

Mechanical properties of Al pure with addition of Cu was investigated. From the analysis, the following can be summarized:

- Mechanical properties of the alloys increased with increase ratio of Cu.
- Hardness values improved with around 300 % as addition of maximum ratio.
- Yield strength and ultimate tensile strength values of alloys are also increment, with addition of Cu and after heat treatment, where yield strength increased 40 N/ mm^2 for base alloy to 57, 80 and 143 N/ mm^2 with addition of 3, 4 and 5 wt.% respectively.
- Addition of Cu alloying element can extend their uses and applications as their mechanical properties enhanced.

5. References

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