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Research Article

Testing the Mechanical Properties of the Alloy (Al-Cu-Mg) by Ultrasonic Technology

Mohammed Al- Maamori[a*], Jassim M. Salmana and Osama Ihsan[a]

[a]Faculty of Materials Engineering - University of Babylon , Iraq

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Abstract

Of the most important characteristics of aluminum that made him a precious metal is light weight, durability, and portability recycling, rust resistance, ease of handling, susceptibility to the formation and electrical conductivity. As a result of this topic characteristics of various colorful areas of the use of aluminum and became its use is necessary in our lives so that we cannot aviation, or ride a valuable trains and fast cars as he cannot get heat and electricity in our homes without it. Showed results that have been reached in this study the possibility of measuring mechanical properties using ultrasound technology

Keywords: *Mechanical Properties, Alloy, Ultrasonic Technology*

1. Introduction

The aluminum light metals where dependent mechanical properties of aluminum and its alloys on the degree of purity and the type and quantity of elements alloying involved with him, as well as on the amount of modulation plastically cold that being for him, where he works forming cold to distort the microstructure and increase the density Alankhalaih and resistance to the movement of particles and thus increases the tensile strength as well as hardness and less ductility amounts commensurate with the amount of cold forming aluminum metal as well as for severe susceptibility to dissolve hydrogen in the process of smelting is the only gas soluble in molten aluminum in large quantities(IJ, Qolmear *et al*,1989;Q.G, Wang*et al*,2001).

Alloying elements present in aluminum are of two types:

1 - Elements present in small quantities or slim nor inevitable presence and this could be considered Kmtdmanat or impurities.

2 - Elements added in specific quantities and information to give specific properties of aluminum and called these elements Alloying elements(ŰíĎÇÁ cream Yas,2000).

These items are working on the configuration of static solutions which lead to a strengthening of aluminum and when the thermal treatment of these alloys deposited other phases in addition to the rigid solution which leads to increase the resistance of these alloys as a result of thermal treatment (M.Murayama *et al*,1997).

The aluminum alloy Copper - one of the most important aluminum alloys in this area where gaining this alloy after heat treatment high mechanical properties as a result of its ability to (precipitation hardening) Alosalad, sedimentation (DHXiao *et al*,2001).

Ultrasonic frequency ranges between 20-20,000 Hz. The ultrasound shall be reluctance High any energy We found that the sound waves audible are those that are less compressed audio from 10-6 Pa high to conduct tests and measurements and can be used for different kinds of materials (such as castings, forgings, Almlhomat, composite materials), and is also used in medical imaging and adopt the idea of the work of medical devices on the ultrasound that falls on the body and reflected him like Maigom by bats that fly in the night assisted by ultrasound caused by a fall on the objects in front of him and reflected it and heard it determines the course without the need for a sense of vision for the inferred on the road so can fly at night. Whales are also used in the sea ultrasound and used as a naval submarine radar works in the depths of the ocean to detect enemy submarines (Hussein Jassim Alalkkawi,2008)

2 Experimental work

2.1 Preparation of samples

Have been prepared (9) Samples way plumbing metal mold and dimensions are shown in Table (1), one sample of pure aluminum and (8) samples of the alloy with the basis of aluminum with addition copper and magnesium ratios grains are shown in Table (1) .

*Correspondinh author: Mohammed Al- Maamori

2.2 Sample preparation steps plumbing in the metal mold

1 - Aluminum wire cutting into small pieces Atrlouh 1-2 cm in length and weighing 120 g and put it in Bodqp Alsralamodhh Figure (1)
2 - Crucibles mode in electric smelting furnace shown in Figure (2) and install the temperature at 720 degrees Celsius to ensure that all the amount of aluminum melting within Crucibles
3 - Two dimensions been Sralalmenyum and the situation became liquid was poured into a mold metal circular aperture section dimensions (diameter of 15.6 mm and length 120 mm) and in this way has been prepared sample of pure aluminum alloy:

Table 1: Chemical composition (percentage weights) and the dimensions of alloy used

Length (cm)	Mg wt%	Cu wt%	Al wt%	No.
11.4	0	0	100	1
11.3	1	1	Base-	2
11.1	1	2	Base-	3
11.6	1	3	Base-	4
11.3	1	4	Base-	5
12.6	0.4	4	Base-	6
13.4	0.6	4	Base-	7
12.9	0.8	4	Base-	8
13.4	1.2	4	Base-	9

1 - Aluminum wire cutting into small pieces Atrlouh 1-2 cm in length and weighing 100 grams and Ozaha at smelting Bodqp.
2 - Crucibles mode in electric smelting furnace and install the temperature at 750 degrees C to ensure that all the amount of aluminum melting inside Crucibles.
3 - two dimensions been Sralalmenyum and the liquid state became been additionhim amounts of Cu and Mg chopped into small pieces (0.5-1 cm) grains rates C Modho in the table (1-2) in several well-wrapped aluminum foil of paper and left immersed in molten aluminum for a period of 10 minutes with continued heating, then was molten mixture by mixing mixer made of Alakravet, then pour molten metal into the mold, and Figure (3) represents the samples were obtained.

Figure 1: Smelting Bodqp

Figure 2: electric smelting furnace

Figure 3: The samples used in the search

2.3 To create samples for check Allotlavi by ultra-sound: Remove excess parts of castings by using the lathe.

The device used: -
The ultrasound device used for the purpose of the test consists of tools or the following number: -

1-Electrical pulse generator -
This part of the device is responsible for generating an ultrasound be generated when the form of vibrations or pulses will pass through the material to be tested these pulses turn electrical energy into mechanical vibrations and thus to the ultrasound.
This shift happens when the pulsating heartbeat transfer or send electric shocks to an existing quartz crystal inside another part called the transmitter and sensor probe during this turn electrical energy into mechanical vibrations transmitted ultrasonic properties through the material for the purpose of identifying defects.
2-Transducers (one pair) -
That any suitable type of transducer works adapters extent of frequency (Clio 20-150 Hz) power can be used in this type of testing. Table 2 shows the frequency of power transformers of different path lengths natural

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Min length of sample	power transformers of different path lengths naural	(path)
(mm)	(khz)	(mm)
25	150	Up to 500
70	>60	500-700
150	>40	700-1500
300	>20	Above 1500

Which is based (piezoelectric) There are two types of power adapters first type piezo-electric converting electrical energy to ultrasound waves and the second type is a precision magnetic Both types can be used when carrying out the tests but the latter type is more favorable in testing situations that require a low frequency. That each device has a pair of transducers any composed

of Mgesan first carrier is energy, which receives electrical energy in the form of shocks of the spring and through the development of quartz found inside the probe carrier turn this electrical energy to mechanical energy and send it through the material. Either the sensor II He is the recipient mechanical (waves), which re-converted into electrical waves again.

3 - Electronic Time tool: -

This tool is able to calculate the time period since the beginning of the pulse generated when the sensor carrier wave and the beginning of the recipient reaches the sensor pulse.

The Tool Time can be of two types one of them used Konbob rays cathode that is the view of electric power for the purpose of studying and analyzing the location and intensity for the signal received after passing through the sample and the second type is used as the timing of the period and that are of screen you are viewing the time it takes the wave as it travels through the sample If both types are used, the results are accurate.

4 - Preamplifier: -

Contains an ultrasound machine to control organizations in the depth and range through the amplifier, which usually works between (0.5 - 12) Mika Hz.

Figure 4: A generation of ultrasound used in conducting the test

2.4 Conduct the test -

In this type of test that pulse wave ultra sound was used by the power adapter carrier that has been developed in the case of contiguity with one of the surfaces of the test sample and after moving through the material and the length of the path of a certain amount (L) which is equal to the length of the sample, the wave oscillating within the article turned into a signal Power by the second sensor is a sensor recipient that has been developed in the case of contiguity with the other sample surface. Electronic Time tool has the function of time it took during the oscillation wave inside the material and amount (L).

2.5 Testing Steps

Device was used ultrasound scan shown in Figure (4) by means of the following steps:

1 - a gel on two end Aldaúreeten to the cylindrical-shaped sample shown in Figure (1)

2 - Develop Mgesa the device (probes) on the gel and then measure the passage of time acoustic wave benchtop during each sample, and thus the table was obtained (No. 3), which represents the time of the passage of the wave for each sample.

Table 3 Represents the passage of time acoustic wave benchtop each sample of samples used to search

The time of the passage of the wave μs	**Mg wt%**	**Cu wt%**	**Al wt%**	**No.**
18.6	0	0	Base-	1
18.5	1	1	Base-	2
18.15	1	2	Base-	3
19.4	1	3	Base-	4
18.5	1	4	Base-	5
21.5	0.4	4	Base-	6
22.3	0.6	4	Base-	7
22	0.8	4	Base-	8
23.2	1.2	4	Base-	9

4 - speed longitudinal was calculated for each sample .

5 - speed transverse was calculated by placing one Almgesan when the circular base of the sample probe and the other at the other end with an offset of (1cm)

3 Results and Discussion

Has been the results that have been reached during the current study and discussion, where was calculated constants mechanical represented by a factor of flexibility and shear modulus ratio Boisn Polsth waves ultra sound and comparing the results process standard, as well as the extraction of the equation to calculate the compressive strength theory technology waves benchtop acoustic alloy (AL-Cu -Mg).

3.1 calculate the longitudinal speed

Longitudinal Speed was calculated for each sample by applying the law below

$$\mathbf{V_L = (L / t)*10}$$

(Km / s) (longitudinal-velocity VL=

L=length of sample (cm)
t= time transfer longitudinal pulse through sample (μs.)
Have been installed all values (vL) in table (4).

Table 4 Represents the longitudinal velocity of each sample

VL K m/s	Mg wt%	Cu wt%	Al wt%	N0.
5.685	0	0	Base-	1
6.003	1	1	Base-	2
6.115	1	2	Base-	3
6.075	1	3	Base-	4
6.007	1	4	Base-	5
5.86	0.4	4	Base-	6
5.979	0.6	4	Base-	7
5.863	0.8	4	Base-	8
5.818	1.2	4	Base-	9

3.2 Density

Density was calculated (DENSITY) of the samples used in this research by using the following laws:
DENSITY (ρ)=mass/volume
VOLUME =π/4(diameter)^2*high
The results were as follows:

Table 5 Represents (ρ) and weight of each sample

g/cm3 ρ	Mass (g)	Mg wt%	Cu wt%	Al wt%	N0.
2.95054	64.7888	0	0	Base-	1
2.94261	56.9732	1	1	Base-	2
2.90472	58.7582	1	2	Base-	3
2.95051	59.2363	1	3	Base-	4
2.96656	59.4385	1	4	Base-	5
2.90984	60.6968	0.4	4	Base-	6
2.92804	66.4032	0.6	4	Base-	7
2.91305	69.3533	0.8	4	Base-	8
2.92889	69.3331	1.2	4	Base-	9

3.3 The relationship between Longitudinal speed (VL) and density

Note whenever increasing density (density) result Alazafah the increasing speed of sound waves and this increase is not proportional (Figure 5) Malk shows.

3.4 Relationship between longitudinal speed and the percentage increase Gravimetric (wt%) of copper certified the percentage Gravimetric (wt%) of magnesium when (1%)

Note increases the speed of ultra-sound (VL) to increase the relative percentage of copper (cu) to the extent (2%) and then after these less and Malk interpretation attributed to consists Torjdid that affect the speed of sound (Figure 6) Malk shows.

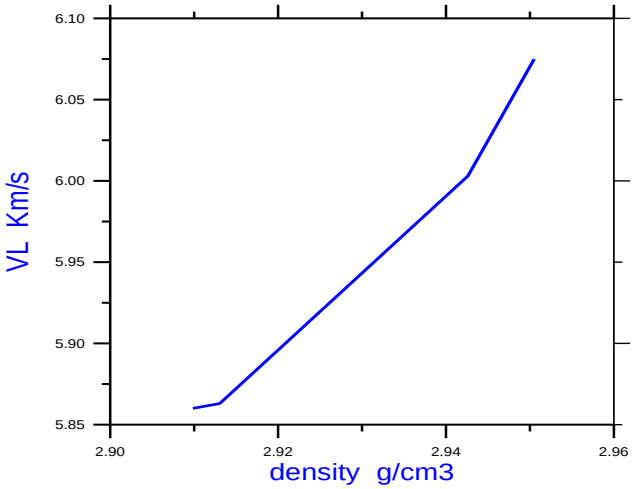


Figure 5 Shows the relationship between longitudinal speed and density

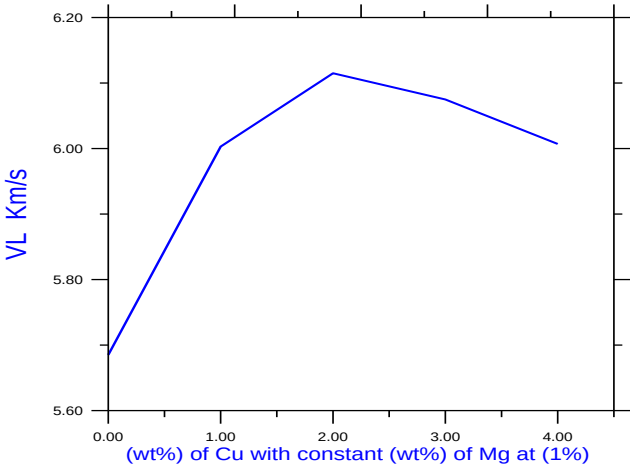


Figure 6 Shows the relationship between the longitudinal speed and the percentage increase Gravimetric (wt%) of copper certified the percentage Gravimetric (wt%) of magnesium when (1%)

3-5 Relationship between speed longitudinal ((longitudinal-velocity and increase the percentage Gravimetric (wt%) of magnesium certified the percentage Gravimetric (wt%) of copper when (4%)

Note increases the speed of ultra-sound (VL) increase the percentage of magnesium relative to the limit (0.6%) and then after these less and Malk interpretation attributed to consists Torjdid that affect the speed of sound (Figure 7) Malk shows.

3.6 calculated speed transverse was for each sample by applying the law below
$V_t = (L / t)*10$

3.7 Done calculated constant mechanical (E,G, υ) by apply modes below

$$\upsilon =[1-2(V_T/V_L)^2]/[2+2(V_T/V_L)^2] \quad (3)$$

where :-
υ = Possions ratio
V_T=Longitudinal velocity
V_L=Transverse velocity

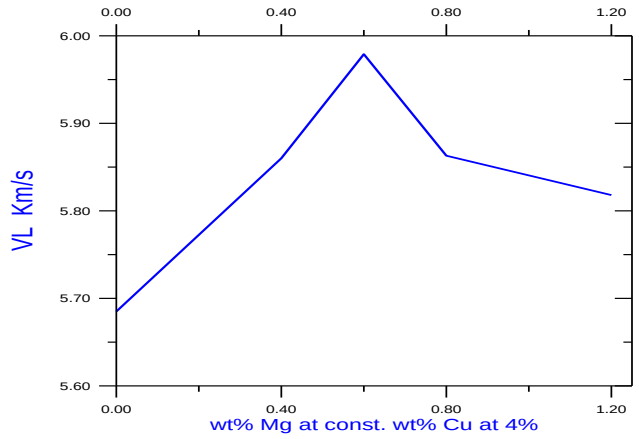


Figure 7 Shows the relationship between speed longitudinal ((longitudinal-velocity and increase the percentage Gravimetric (wt%) of magnesium certified the percentage Gravimetric (wt%) of copper when (4%)

$$E=[v_L^2\rho(1+\upsilon)(1-2\upsilon)]/(1-\upsilon) \quad (4)$$

Where:
E=youngs modnlus (Gpa)
ρ =density (kg/m^3)
υ=Possions ratio
V_L=longitudinal velocity (m/sec)

$$G= E / 2(1+\upsilon) \quad (5)$$

Where:
G=shear modulus (Gpa)
E= young's modulus (Gpa)
υ = poisons ratio

The results in below table

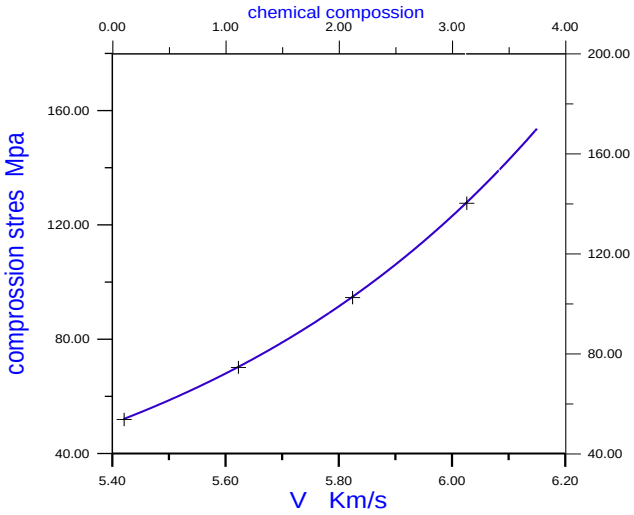
G GPa	E GPa	υ	Mg wt%	Cu wt%	No.
29.48	75	0.27	0	0	1
30.43	79	0.3	1	1	2
33.85	86	0.27	1	2	3
34.31	87.15	0.27	1	3	4
34.72	87.5	0.26	1	4	5
30	77	0.28	0.4	4	6
31	80	0.29	0.6	4	7
32.48	81.85	0.26	0.8	4	8
32.8	82	0.25	1.2	4	9

The results standard in below table

G GPA	υ	E GPA
27.65 – 31	0.29 – 0.32	69 - 73

3.8 Found equation to calculate compression stress for alloy (AL-Cu-Mg)

It can by represent data of lab to compression test and speed longitudinal on curve below



By calculated equation of this curve we can from found equation calculate compression stress for alloy (AL-Cu-Mg) ,the equation is :

C.S = exp(1.483 * V_L) * 0.0169
C.S=compression stress (Mpa)
V_L=Transverse velocity (Km/s)

4 Conclusions

1 - Can be dispensed to extract mechanical inspection of mechanical constants by a factor of flexibility and shear modulus and proportion Boisn through the use of ultra-sound technology.
2 - The ability to calculate the compressive strength For alloy (AL-Cu-Mg) using ultra-sound technology.
3 - The results of the tests with ultra-sound technology was the very approach to the results of the standard process.

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