Macro Analysis on the Mixture of Metals 77 % Cu 23 % Zn

Sri Wuryanti

Department of Energy Engineering, Politeknik Negeri Bandung, Indonesia

Abstract: ***This macro analysis is useful to observe physical. Alloy is a metallic material that is stronger than pure metals, because metals are crystalline solids. There are three parameters will be analyzed, i.e. density, heat capacity and electrical conductivity. There are three parameters will be analyzed, i.e. density, heat capacity and electrical conductivity. The results: the bulk density of 8.296 g / cm^3, the heat capacity equation, with a = 177.7914, b = 0.6464, c = - 5, 677, 645.692 and the lowest and the highest of electrical conductivities were 65.88 S/cm and a maximum 38.43 S/cm, respectively.***

Keywords: Alloy, Density, Electrical conductivity, Heat capacity, Metal

1. Introduction

Based on both characteristic and goal to be realized in a micro analysis, the right use of tools will be leading to achievement of reasonable macro analytical goals. Density in some applications has much use in understanding the composition of a material, and indicating causes of flawed material. The mass density was measured by picnometer. Thermal capacity is useful to observe physical change in sample as a function of temperature to be analyzed by using DSC (Differential Scanning Calorimetry) [1, 2]. Conductivity of electricity is one of important aspects in making analysis of a material, it is not just restricted to uniformity, for example, how right a material in conducting electric current under analysis using LCR (Inductance, Capacitance, Resistance) meter [3].

2. Material Preparation

Cu 77% - Zn 23% were washed in an ethanol cleansing liquid to avoid them from contamination by other materials and filed down to obtain shine metal.

Density testing

A Pycnometer was utilized to measure the density. The mass data was obtained using this instrument. From these data, the density was calculated using an equation,

$$\rho_s \quad = (m_{p+s} - m_p) / (V_p - V_{alc}) \qquad (1)$$

Where:
mp+s = mass of picno and sample, g
m_p = mass of picno, g
V_p = (masspicno + alc. - masspicno)/ρalc., ml
Valc. = (masspicno + alc + sample.-masspicno + sample) / ρalc., ml

Heat Capacity Testing

The heat capacity was measured using a DSC [1]. The results of this testing is data of the heat flow in the scoreless dishes, called the S1 signal, whereas the data output of heat flow with an empty dish - standard samples, called the S2 signal. Furthermore, the data of heat flow to the dish containing the test material - standard sample, named the S3 signal. These data were calculated using regression. The value of heat capacity of a material is not a constant, but a function of temperature. Empirical equation for the heat capacity is as follow,

$$C_p\, T = a + bT + cT^{-2} \qquad (2)$$

Where a, b and c are constant, the values depending on the type of material. For example, for high purity Alumina, the values of a = 114.8, b = 12.8 x 10-3 and c = 35.4 x 105

Electrical Conductivity Testing

The tests of electric conductivity were conducted by using LCR type HIOKI, Model 3522-50, Frequency 42Hz to 5MHz with Accuracy ±0.08%. Measurement signal 10μA to 100mA rms, Output impedance 50Ω. Measurement type 5ms (fast); 21ms (normal), Rated power 50VA. Record measurement data includes impedance, conductance, parallel barriers, frequency and imaginary components.

3. Results and Discussion

From the experimental density -Zn 77% Cu 23 %, is obtained, the mass is in the air and masses within the fluid, as described below.

Table 1: Measurement results of density

Substance	ms, A (gr)	ms, w (gr)
Cu 77% - Zn 23 %	1	0.9

A Pycnometer was utilized to measure the density. The mass data of Cu 77% - Zn 23% was obtained using this instrument. From these data, the density was calculated using an equation,

$$\rho_s = \rho_l \frac{m_{s,a}}{m_{s,a} - m_{s,w}}$$

$$\rho_s = 0,99774 \, {}^{gr}/_{cm^3} \, x \frac{1gr}{1gr - 0,9gr}$$

$$\rho_s = 9,9774 \, {}^{gr}/_{cm^3}$$

Trials offer the proportion of density some 9.9774 gr/cm^3. As compared to density of Cu [4] and multiplied by composition of material: 77%wt x 8, 954 gr/cm^3 = 6, 895 gr/cm^3 and 23 %wt x 7, 144 gr/cm^3 = 1, 643 gr/cm^3 Zn, the density of material is 8.538 g/cm^3.

The experimental results of heat capacity, as tabulated in Table 2

Table 2: Measurement results of heat flow S_1, S_2 dan S_3

TEMP	T (K)	T^-2	S1	S2	S3	S2-S1	S3-S1
149	422	5.62E-06	197.127	1.998.701	2.214.031	0.274317	2.427.612
150	423	5.59E-06	1.970.996	1.999.148	2.213.953	0.281522	2.429.571
151	424	5.56E-06	1.970.787	1.999.329	2.213.753	0.285424	2.429.661
152	425	5.54E-06	1.970.634	1.999.411	2.213.594	0.28777	2.429.597
153	426	5.51E-06	1.970.527	1.999.518	2.213.308	0.289902	2.427.808

Subsequently, coefficients a, b, and c might be found in Table 2 and results may be obtained by using regression (excel) as shown in Table 3.

Table 3: The results of the regression calculation of heat capacity

Summary Output

Regression Statistics						
Multiple R	1					
R Square	1					
Adjusted R Square	1					
Standard Error	4, 33E-09					
Observations	76					
ANOVA						
	df	SS	MS	F	Significance F	
Regression	2	4.467.633.749	22.338.169	1.2E+30	0	
Residual	73	1, 37E-20	1, 87E-24			
Total	75	4.467.633.749				
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.777.914.194	1, 37E-06	1, 30E+16	0	177.791.419	17.779.142
T (K)	0.646440517	2, 09E-09	3, 09E+16	0	0.64644052	0.6464405
T^-2	-5.677.645.692	8, 70E-02	-6, 53E+15	0	-5677645.69	-5677645.7

Based on data in Table 3 and using Eq. (2), a equation of heat capacity,

$$Cp\ (T) = 177.7914 + 0.6464\ T - 5677645.692\ T^{-2} \quad (3)$$

Where: a = 177.7914 b = 0.6464 c = - 5677645.692

The main macro characteristic of Cu 77% - Zn 23% are determined by the electrical conductivity value, data listed in figure 1, whereas the results are shown in figure 2.

The sample of LCR under experiment produce results in the form of parallel obstacles and imaginary components.

The sample of LCR under experiment produce results in the form of Frequency, impedance, conductance, parallel obstacles and imaginary components. Experimental data graphed as mentioned below.

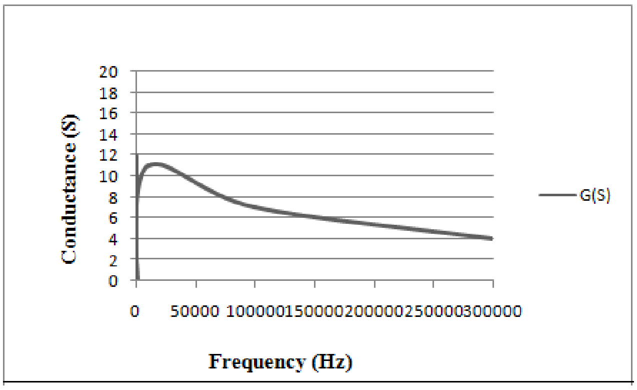

Figure 1: Measurement results of LCR

Frequency - f(Hz), impedance -Z (Ohm), conductance –G (S), parallel obstacles

-Rp (Ohm) and imaginary-X(Ohm) components were included in an equation to find Resistivity -σ (S/Cm).

$$\sigma = G(S)\frac{t(Cm)}{A(Cm^2)} \quad (3)$$

Where:
t = thick of metal = 0.00118 (Cm)
A = the surface area of metal = 0.000215(Cm^2)

Therefore, value σ (S/Cm) in each conductance G (S) as shown in Table 4.

From the test LCR, electrical conductivity value obtained at least 100 Hz frequency of 65.88 S / cm, the highest frequency of 100000 Hz for 38.43 S/cm.

Based on the equation, we found a thick factor and the surface area have effect to be multiplier than conductance, so conductivity of electricity is highly influenced by material type and size.

Table 4: The results of electrical conductivity

Frequency (Hz)	Conductance (S)	Electric Conductivity (S/Cm)
100	12	65.88
1000	11.5	63.14
10000	11	60.39
100000	7	38.43

4. Conclusions

From the macro analysis is obtained, the bulk density of 9.9774 g / cm^3, the heat capacity equation Cp (T) = 177.7914 + 0.6464 T - 5677645, 692 T^{-2}, and the electrical conductivity at least 100 Hz frequency for 65.88 S /cm, the highest frequency of 100000 Hz for 38.43 S /cm

References

[1] B.R. Jaishi and P.K. Mandal, Optical microscopy, DSC and X-ray diffraction studies in binary mixtures of 4-pentyloxy-4′-cyanobiphenyl with three 4, 4′-di (alkoxy) azoxybenzenes, Liquid Crystals, Vol. 33, no. 7, pp. 753–765, View at Publisher · View at Google Scholar · View at Scopus, 2006.
[2] Parkin Elmer, Diffrential Scanning Calorimetry. USA: a Beginner's Guide, Waltham, MA 02451, 2010.
[3] Donghui Xu, Geometric amplitude factor in an LCR circuit with time-dependent inductance, capacitance and resistance, Journal of Physics A: Mathematical and General, Volume 35, Number 45, 2002
[4] H. L. Hong, Q. Wang, C. Dong and Peter K. Liaw, Understanding the Cu-Zn brass alloys using a short-range-order cluster model: significance of specific compositions of industrial alloys, Scientific Reports 4, Article number: 7065, 2014