Effect of The Heat Treatment on Properties of The alloy (Ni-Cu-V) Nanoparticles Prepared by Powders Technology

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Abstract

In this paper , nanostructure alloy was prepared (70% Ni, 25% Cu, and 5% V) via metallurigical technique. Three component of powders were used as a nanoparticles dimensions, to produce an optimum alloy. The dried alloy kept at 800 ^{0}C for 30 minutes under 10 Ton of the cold pressing, the process of sintering was carried out at different temperatures 500 ^{0}C, 700 ^{0}C, 900 ^{0}C and room tempreture for 60 minutes . The effect of the heat treatment on the density, porosity, water absorption and the hardness values (Rockwell Method) were all examined in this work. Moreover, the effect of heat treatment on corrosion resistance of the alloy was investigated by immersing the samples in a solution of (3.5% NaCl) for different period namely (3,5,7,9,11day). The results show that porosity , ratio water absorption decrease with increasing hardness values after heat treatment. In addition, the wear resistance increases with increasing of sintering temperature. Atomic force microscope images illustrate that grain sizes increase with increasing of sintering temperature and the surface of the nanoparticles has homogeneous structure with sintrening temperatures. Simple design and high quality of nanostructure alloy play a key role to improve of mechanical and physical properties.

Key words: Physical properties, Powder technology, Heat treatment, Porosity, Hardness.

I. INTRODUCTION

Metal-coated conductors such as Cu coated Al wires , and Ni coated Cu wires have attracted much interest, mainly owing to massive applications in power transmissions, electrical interconnections and microcomponent connections. In fact, these conductors offer striking advantages compared to traditional single-metal conductors [1]. Environmental conditions have a significant effect on the physical properties of engineering materials, which open the door for huge applications [2, 3]. Nickel and Copper alloys have made a substantial progress in both industrial and technical fields due to the fact that particularly for Nickel which does not mix with some metals as it has a very small solubility and high difference in fusion heat degrees [4]. The mean goal of related studies is to improve the mechanical and physical properties of (Ni-Cu-

V) Nanoparticles Alloy. Powder metallurgy can create parts that would otherwise be difficult to form, including those with complex shapes or porosity. However the mechanical and physical properties of precipitation have produced in meteorological techniques are weak mainly with those which are produced by plumbing, so adding another elements to improve those characteristics is important. One of the interesting metal mixture is vanadium element powder, which was added to mix nickel and copper powders in order to obtain the best alloy specifications. After a complete mixing process, the piston operation carried out by a hydraulic piston. The sintering temperature was then performed in an electric furnace using Arcon gas as an inert gas to prevent oxidation during sintering [5,6]. Recently, many of works attracted attention to investigate Ni,Cu and V materials. Nathom et al. in 2011 has formed Ni-Cu alloy using metallurigical technique [7]. Furthermore, Abdullah in 2018 tested structure properties of Ni-Cu, Vanadium powder added with percent (0, 1, 2, 3) % [8]. In this work, the nanostructure alloy was fabricated with (70% Ni, 25% Cu, 5% V) by metallurigical technique. The mechanical properties of alloy shown a good properties such as corrosion resistance and hardness with sintering temperatures which is used to improve surface finish and appearence.

II. MATERIAL PREPARATION

The (Ni-Cu-V) alloy was formed from high purity powders , the powders were mixed (70% Ni, 25% Cu, 5% V), and they were dried at 800 °C for half hour. After that, molds with dimensions of high =1.6 cm, radius = 0.5 cm was used for casting the samples as shown in Figure 1. And then, the sample were pressed down under a hydraulic piston of 10 ton . Heat treatment of samples was carried out by a German oven type (Renfert) model (Magma) at different sintering temperatures (500 ^{0}C ,700 ^{0}C, 900 ^{0}C) for one hour. Heating rate was kept at 6 ^{0}C/min. Finally, the sample were cooled slowly. Table (1) shows the grain size and the and purity of prepared metallic powder .

Table 1. Data of grain size and purity of metallic powder.

Powder	***Grain Size (nm)***	***Purity %***	***Origin***
Nickel powder	*95*	*99.99*	*Merck Co.-GERMANY*
Copper powder	80	*99.98*	*Buchs Fluka AG Co.-GERMANY*
Vanadium powder	85	*99.95*	*Buchs Fluka AG Co .-GERMANY*

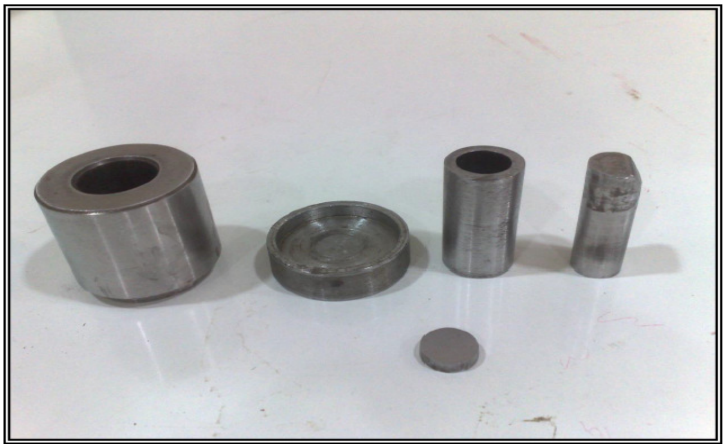

Fig. 1. The mouldings of the samples.

Experimental Procedures

The apparent density, porosity and water absorption have been calculated using the Archimedes method by drying samples for an hour (oven temperature at 100 °C). The samples were weighed after removed from the oven in order to calculate the dry weight (W_d). Afterward the samples immersed in a pot filled with water for a period of 24 hour .Then, they were taken out off the water and dried off, and from water drops stuck up on its surface by a cotton cloth to make sure that the samples do not presse by cloth, so that the water in the external pores of samples is not pull . Next step , the samples is weighted again to find the saturated weight (W_S) . The weight of the samples was measured in suspended way and this step shown in Figure 2 . Subsequently , the saturated sample with water was put on the grid to be weighed and hanged in water and this weight represents the hanging weight (W_i) .

Fig. 2. mesh on the balance for measuring the weight hanging .

The apperent density (A.D) was calculated by the given relationship [9] :

$$A.D = \frac{Wd}{Wd - Wi} \times \rho \quad \ldots\ldots\ldots\ldots\ldots..(1)$$

Where ρ is the density of water (gm/cm^3). Whereas the apperent porosity (A.P) was found by the mathematical relationship [10] :

$$A.P = \frac{Ws - Wd}{Ws - Wi} \times 100\% \quad \ldots\ldots\ldots\ldots\ldots..(2)$$

The value of water absorption ratio (W.A) can be detrmained by the following equation [11] :

$$W.A = \frac{Ws - Wd}{Wdi} \times 100\% \quad \ldots\ldots\ldots\ldots\ldots..(3)$$

The samples were cleaned and weighed by using balance type (Optika Level SR 6532-Italy) and immersed into a solution (3.5% NaCl) for different time periods (3, 5, 7, 9, 11day), after that , the samples were extracted from the solution and dried and finaly reweighed .The amount of weight loss was calculated by given equation [12] :

$$W = \frac{Mg - Mi}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(4)$$

Where Mg is block the sample before immersion in the middle of erosion, and Mi is Block the sample after a period of immersion, whereas, A represents surface area of sample.

III. Experiment and Result

1. Physical tests of alloy (Ni-Cu-V)

Figure 3 shows the apparent density of the samples as a function of sintering temperature. It can be clearly seen that the apparent density increases as the sintering temperature increases. This could be, mainly due to decrease in the pores and enhancement of alloy homogeneity. The result is agreement with the work done by [13, 14].

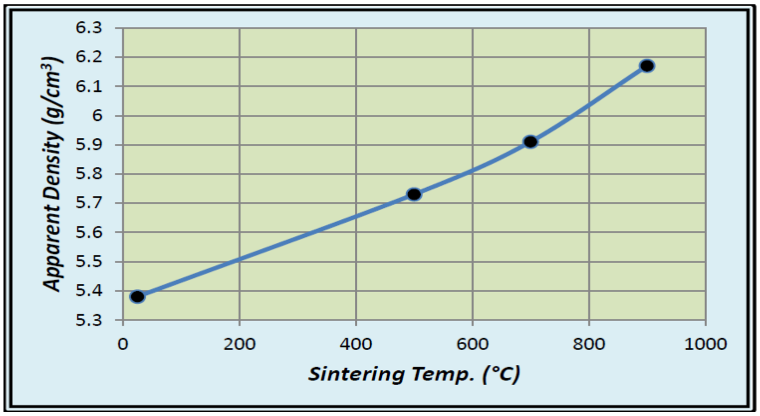

Fig. 3. Apparent density versus sintering temperature.

On the other hand, Figures 4 illustrates the porosity values of the alloy as a function of sintering temperature, whereas Figure 5 shows the sintering temperature dependency on the water absorption . Both Figures approve that the porosity and absorption values decrease with increasing sintering temperature . Increasing of sintering time leads to an increase bonding between powder grains .In addition, these pores decrease and change in a shape . The results of porosity and absorption values confirm that they are compatible and behavior inversely to virtual density.

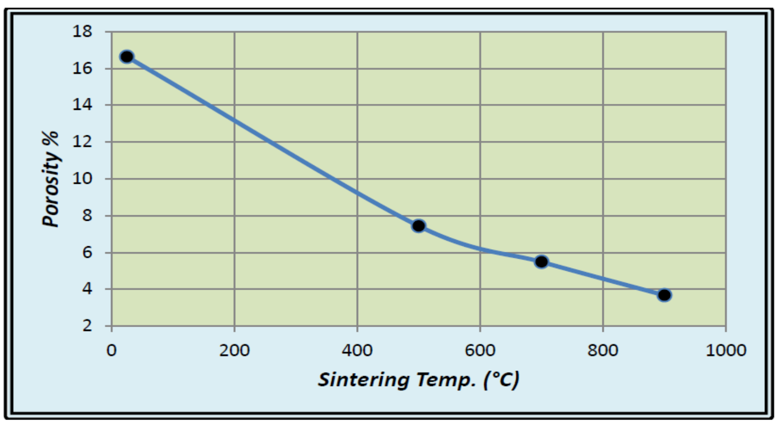

Fig. 4. Apparent porosity as a function of sintering temperature.

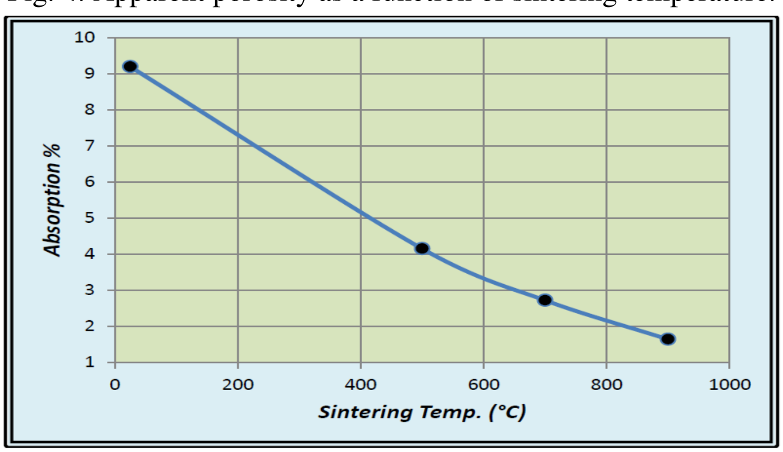

Fig. 5. Absorption as a function of sintering temperature.

Moreover, Figure 6 shows the large amount of weight loss of the sample versus immersion time at different sintering temperature namely (500 ^{0}C, 700 ^{0}C, 900 ^{0}C) and room tempreture . The result indicates that the corrosion resistance decreases whenever the time of immersion increased.

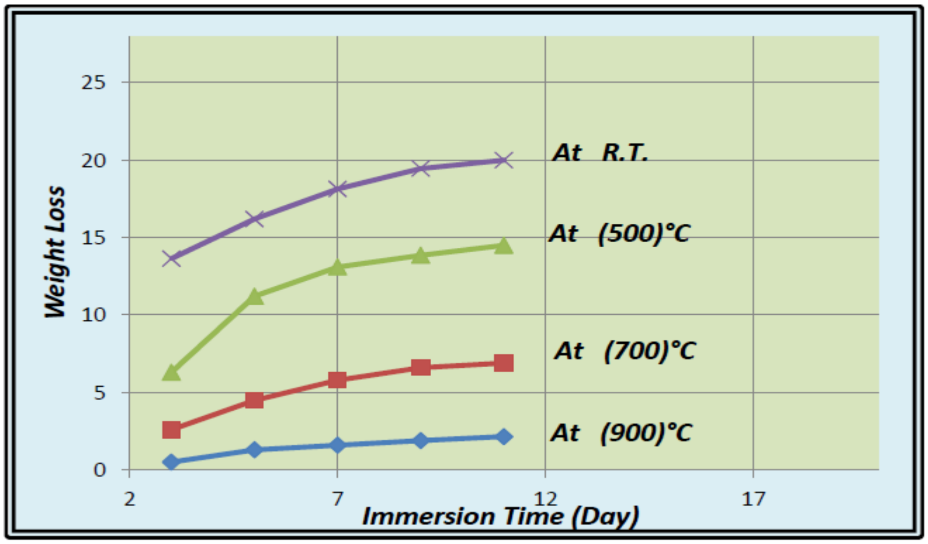

Fig. 6. Weight loss versus immersion time at different sintering temperature.

In addition, Figure 7 shows the hardness values (HRC) (gm/mm^2) of the sample at different sintering temperature. It evidents from this Figure that the hardness values of the samples increase with sintering temperature, this result is harmonious with work [15].

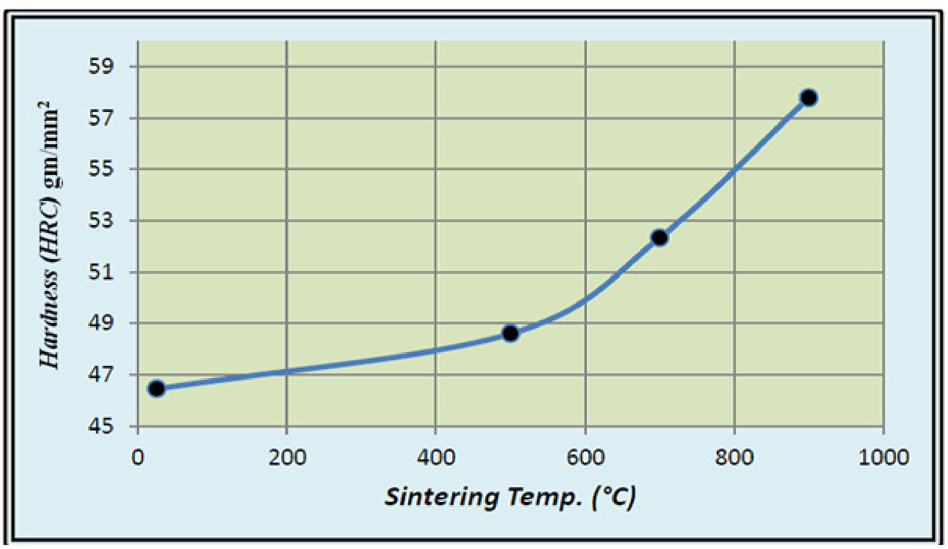

Fig. 7. Plot of hardness versus sintering temperature.

2. Surface morphology of alloy (Ni-Cu-V)

Figure 8 shows Atomic force microscope (AFM) of The alloy (Ni-Cu-V) nanoparticles annealed at 500^{o}C, 700^{o}C and 900^{o}C and room tempreture. It can be seen the grain size increases gradually with increasing sintering temperatures. Furthermore, the surface of nanoparticles was smoothness with increasing of sintering tempretures , this is leading to improve of crystallization process at 900^{o}C . Thus, the surface of the nanoparticles has homogeneous structure with sintrening temperatures [16].

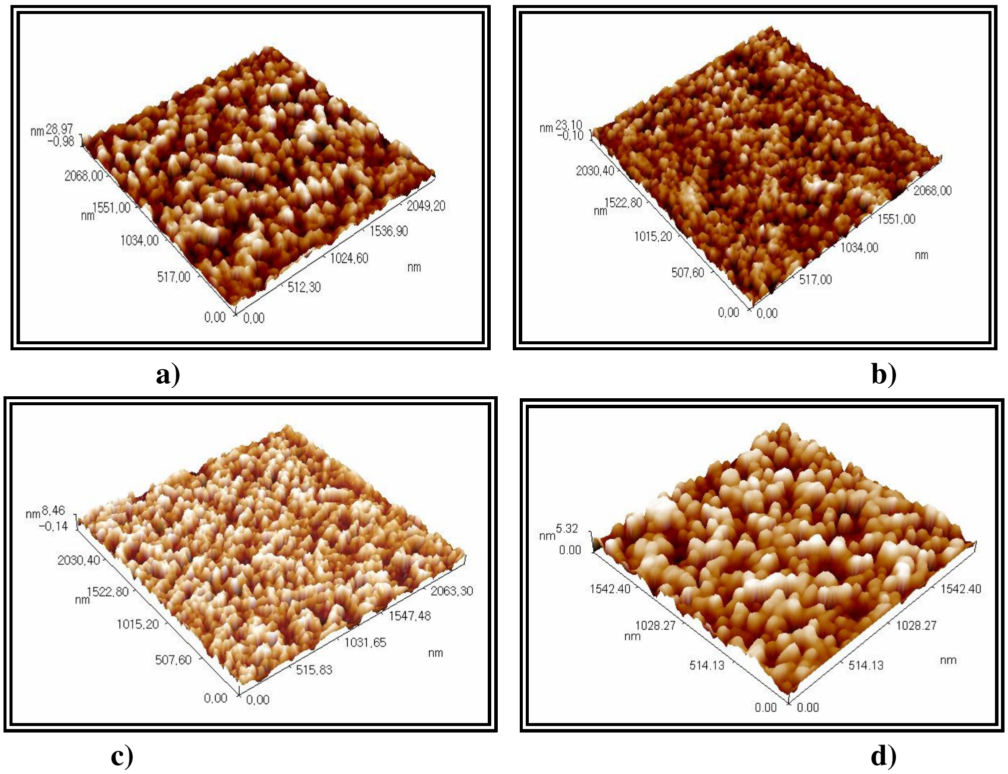

Fig. 8. AFM images of nanoparticles alloy a) room tempreture , b) 500 ^{o}C, c) 700 ^{o}C , and d) 900 ^{o}C

IV. CONCLUTION

As a general overview in light of the outcomes of the study, there is a good respond between both apparent density and hardness values with sintering temperature. Moreover, porosity and water absorption manipulating is possible by heat treatment through controlling the sintering temperature. In addition, the positive sign which received is by increasing temperature of sintering, the corrosion resistance also increases and this can open the possibility of improving the properties of the samples. the surface of the nanoparticles has homogeneous structure with sintrening temperatures. What is more, the establish of an optimal alloy could be at hand by careful adjustment of experimental circumstances.

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