Surface analysis and roughness parameters of Copper Metallic

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ABSTRACT. The level of copper (Cu) distribution in the hard alloy depends little on powder material hardness although the other mechanical properties of the materials and the crystal structure of copper is face centered cubic (FCC). A discussion about simple and low cost preparation of copper powder by (Mini Mill 2 Panalytical) and preparation of the sample was rotating at 5 min and in the case of grinding of samples at high speed 300 rpm. The surface morphology of copper metallic powder was determined with Scanning Tunneling Microscope (STM) (Model: NTMDT Solver Nano.). The characterization of surface topography and surface measurement determines surface topography and surface measurement copper includes roughness parameter. X-ray fluorescence analysis is a powerful analytical tool for the determination of almost all the elements present in a sample. The spectra obtained were analyzed using a X-ray fluorescence (XRF) (Model: Rigaku-NEX CG). Each element emits a unique spectrum of X-rays characteristic of that element. From the spectra obtained, there was the element to be present in the sample was copper (Cu).

1 INTRODUCTION

The copper atom is quite similar to an atom of gold or silver [12]. Within the copper atom lattice a cloud of free electrons is uniquely available for the transfer of electrical current. Solid copper can be described as the arrangement of copper atoms in a face-centered-cubic configuration [14]. A copper atom is found at each corner and in the center of each face of a cube [10-19]. This is the unit cell which is repeated in three dimensional space to make up the crystal structure of the metal [16-18]. Scanning Tunneling Microscope (STM) in 1982 at IBM in Zurich by Binnig. The tip-sample interaction in STM is based on a tunneling electrical current [15]. Although the ability of the STM to image and measure the material surface with atomic resolution [20]. To better understand the morphology of a surface a quantitative description of the surface topography must be carried out. The topography matrix data should be treated in each profile line (2D). The amplitude parameters are the principal parameters in characterizing the surface topography. The root mean square roughness (Rq) are the most used amplitude parameters. The reason for this is that this parameter is more sensitive to large deviations with respect to the mean line. To know if the Rq values are making sense, the height points have to be uniformly distributed according to a normal distribution curve. The radiation intensity of each element signal, which is proportional to the concentration of the element in the sample [5]. This excitation ejects electrons from the atomic shells of the elements in the sample. When a given atom replaces the ejected electron, by taking another electron from an outer atomic shell, x-ray energies are emitted [6]. Since each element generates a specific energy level in this replacement process, these energies are known as characteristic x-rays [2]. The binding energy of the characteristic X-ray lines depend only on the atomic energy levels so are always the same [3]. The measured intensity of an emission lines depends on the number of corresponding atoms in the sample which were excited but on many other parameters as well. The probability of X-ray emission depends on the element and on the energy of the excitation source [4-9]. The probability of detecting the X-rays depends on the detector sensitivity, attenuation in the sample itself, etc [7].

2 COPPER METTALIC PREPARATION

Before grinding copper metallic powder via Mini Mill 2 Panalytical was cleaned the bowl with acetone for a short time. The hardness of the grinding bowl used and of the grinding balls must be higher than of the Cu used [17]. The grinding bowls and grinding balls of copper are resistance to acids with the exception of hydrofluoric acid. In accordance with the application, the grinding time should be adapted of the bowl. Copper metallic powders have investigated at 5 min and in the case of grinding of samples at high speed 300 rpm.

3 SCANNING TUNNELING MICROSCOPIC STUDY OF COPPER METALLIC

STM is defined as a specific type of microscopy that uses the basic principle of scanning a surface with a very sharp probe to image and measure properties of material. The STM provides real space atomic resolution images through tunneling current between a tip (Pt-Ir) and an copper surface. The probe is a very important component of a SPM because different probes can measure different properties of the sample. The movement of the tip or sample (copper) in the x, y, and z-directions is controlled by a piezoelectric tube scanner, similar to those used in STM. The scanner moves across the first line of the scan, and back. The surface morphology of copper metallic powder was studied by scanning tunneling microscopic as shown in the fig.1. The STM analyses the surface of solid objects, producing images of higher resolution. It produces representation of two dimensional sample from a diverse range of material. From STM images it was found that the root mean square roughness that the image 40 x 40 μm scanning areas with 2000 x 2000 points, and scanning rate of 3.286Hz, applied voltage 2.53 nV and the current between surface iron metallic and tip was 4.825nA.

Fig.1. STM image for surface morphology of 2D of copper metallic 40 x 40 μm .

4 ROUGHNESS PARAMETER: (PEAKS, VALLEYS AND AVERAGE OF ORDINATES)

The characterization of surface topography and its understanding is important in procedures involving friction, greasing and wear [22]. A very important thing to consider is that the variation of the radius of stylus tip may affect the shape of the profiled surface because the radius of the tip of the pen draws a single envelope of the actual profile [24].

4.1 Maximum profile valley depth of the roughness profile(R_v), Maximum profile peak height of the roughness profile (R_p) and Total height of the roughness profile(R_T)

The Maximum Profile Peak Height (R_p) is the measure of the highest peak around the surface profile from the baseline [23]. Likewise the Maximum Profile Valley Depth (R_v) is the measure of the deepest valley across the surface profile analyzed from the baseline and Z is profile of surface as shown in the fig. (2). We can write:

$$R_p = |\max Z(x)| \quad (1)$$

$$R_v = |\min Z(x)| \quad (2)$$

Thus the Maximum Height of the Profile (R_T) can be defined as the vertical distance between the deepest valley and highest peak.

$$R_T = R_p + R_v \quad (3)$$

4.2 Root mean square deviation of the roughness profile (R_q)

The root mean square (RMS) is a statistical measure used in different fields. We cite, as an example, the use of the RMS amplitude applied to harmonic oscillators, such as on an alternating electric current. The root mean square of roughness (R_q) is a function that takes the square of the measures [21]. The RMS roughness of a surface is similar to the roughness average, with the only difference being the mean squared absolute values of surface roughness profiles as shown in the fig. (2). The function R_q is defined as:

$$R_q = \sqrt{\frac{1}{l} \int_0^l |Z^2(x) dx|} \quad (4)$$

Fig.2. Illustration of Maximum Height of the Profile (R_T), Maximum Profile Valley Depth (R_v), Maximum Profile Peak Height (R_p) for the surface profile and Root mean square deviation of the roughness profile (R_q).

5 X-RAY FLUORESCENCE APPLIED TO COPPER ANALYSIS

The plot below show how characteristic X-ray spectra are used to determine the element which is present in a sample [8-11]. When the detector absorbs fluorescence, its conductance changes in proportion to the energy of the fluorescence, which then is processed by the electronics [1-2]. The

intensity, or frequency of occurrence measured in counts per second, on the vertical axis and energy of the fluorescent signal, measured in kiloelectronvolts, across the horizontal axis as shown in the fig. (3). The fluorescent energy identifies the element, while the intensity of the fluorescence is a measure of the element's concentration [13]. The measured intensity of a single emission line, say the Cu K α peak above, depends on the energy spectrum and the intensity of the exciting X-rays, on the efficiency of the X-ray detector, and on the geometry of the source and sample. It also depends on the other elements in the sample. The tube voltage and tube current can be set within 25 kV and 1.0 mA respectively. Copper has a strong peak at 8.047 keV and has a weak at 8.905 keV as shown in the fig.3.

Fig.3. Shows the measured energy spectrum and identifies the major peaks copper.

6 RESULT AND CONCLUSION

The surfaces of the products of copper metallic were obviously roughness. Surface measurement determines surface topography, includes roughness as shown in the fig. (1). Similar to some surface properties such as hardness, the value of surface roughness depends on the scale of measurement. In STM, the Rq depends on the swept area of the sample, the scan size. The Rq is more sensitive to peaks and valleys than the average roughness due to the squaring of the amplitude in its calculation. The evaluated maximum profile valley depth of the roughness profile (Rv) surface roughness of the sample was 1.877(pA), maximum profile peak height of the roughness profile (Rp) was 3.320 (pA), total height of the roughness profile (RT) was 5.197(pA) and Root mean square deviation of the roughness profile (Rq) was 0.952(pA) for copper sample, as seen in the Fig. (2). The measured intensity of single emission line depends on the energy spectrum and of exciting X-rays, on the efficiency of the detector and the geometry of source and sample. It also depends on the other elements in the sample. The XRF study confirms / indicates that the resultant of the copper metallic powder by the spectrum obtained, there were a strong peak at 8.047 keV and has a weak at 8.905 keV as shown in the fig.3.

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