Characterization of a Copper Powder for Heat Pipe Wick Applications

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Abstract—In powder metallurgy, it is necessary to know the powder’s nature to understand how the processing of a powder occurs. In this paper, a characterization of a copper powder for heat pipe wick applications was experimentally done. The copper powder manufacturing method was atomization. This metallic powder was characterized by Scanning Electron Microscopy (SEM), X-Ray Fluorescence Spectrometry (ED-XRF), and Laser Diffraction Granulometry. As a result, the purity and the shape are compatible with the powder manufacturing method and great for wicks. Also, the copper powder has a unimodal distribution that is excellent for capillary structures.

Keywords—copper powder, characterization, heat pipe wick.

I. INTRODUCTION

In essence, powder metallurgy converts a metal powder with specific properties of size, shape, and packaging into a solid, precise, and high-performance form. In this way, powder metallurgy can be defined as the study of the processing of metallic powders, including the manufacture, characterization, and the conversion of metallic powders into useful products for engineering [1]. According to German [2], firstly is necessary to know the powder’s nature to understand how the processing of a powder occurs. Usually, powder metallurgy works with particles larger than 1μm, but smaller than sand (25 μm to 200μm). The Scanning Electron Microscope (SEM) is one of the best available tools for observing the discrete characteristics of a metal powder, such as material, powder manufacturing method, particle size, and shape. The particle size of a metal powder is one of the most important characteristics of powder metallurgy [3]. It is analyzed based on a geometric parameter (diameter, surface area, maximum dimension, volume, among others) and considering a spherical particle shape. There are several techniques of size measurement, such as microscopy, sieving, sedimentation, laser diffraction, and X-Ray [4].

A Tescan™ VEGA3 Scanning Electron Microscopy (SEM) from the Laboratory of Materials Characterization at the Federal University of Technology - Paraná was used to obtain the images presented in this paper.
of the Federal University of Technology - Paraná (LabCM/UTFPR) was used to observe the shape of the copper particles. As a result, a micrograph with a magnification of 500x was taken.

The chemical composition of the copper metal powder was determined by a Shimadzu™ EDX-7000 X-Ray Fluorescence Spectrometer from the Interdisciplinary Laboratory of Ceramic Materials of the Ponta Grossa State University (LIMAC/UEPG).

For the determination of the average particle size, the Laser Diffraction was applied. The technique consists of the scattering of light in a sample of powder dispersed in aqueous medium. A Cilas™ 920 Particle Size Analyzer for a range of 0.3μm and 400μm was used to measure the particle sizes by the Fraunhofer Diffraction Technique. The tests were done in the LIMAC/UEPG. In this particle size distribution analysis, alcohol was used as the dispersing agent under ultrasonic shaking for a period of 60 seconds.

### III. RESULTS AND DISCUSSION

The experimental results regarding the characterization of the copper powder for capillary structures are presented. From the Scanning Electron Microscopy (SEM), a micrograph of the copper particles with a magnification of 500x was obtained and is presented in Fig.2. The shape is approximately spherical.

![SEM micrograph (500x).](Image)

The result of the X-Ray Fluorescence Spectrometry (ED-XRF) shows that the metallic powder is composed of 100% copper, so the purity is very high. According to the results of the SEM and the ED-XRF, the high purity and the shape are exactly as expect from the powder manufacturing method.

The distribution of the particle size obtained by the Laser Diffraction of the copper powder is presented in Fig. 3. In this graph, the X-axis shows the particle diameter [μm]. The Y-axis presents the relative [%] and the cumulative [%] frequencies. The solid line represents the cumulative frequency for each particle size, defined with 30 size classes. The volume-based average particle diameter was 33μm.

![Particle Size Distribution](Image)

According to the distribution, the copper powder behavior is unimodal, which means that there is a size with more frequency. The unimodal distribution is excellent for heat pipe wick applications [4].

### IV. CONCLUSION

This paper presented a characterization of a copper powder for heat pipe wick applications. As a result, the purity and the shape are compatible with the powder manufacturing method and great for wicks. Also, the copper powder has a unimodal distribution that is excellent for capillary structures.

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