INFLUENCE OF CERAMIC MEDIA ON THE EFFECTS OF TUMBLER TREATMENT

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Abstract

The article contains the experimental results of research on the use of vibratory machining with loose abrasive media. The aim of the study was to investigate the influence of vibratory machining time with ceramic media, on geometric surface structure changes, burrs removing and rounding effect. In the study were used CB series ceramic media and ME L100 A22/NF was added as a liquid lubricant. The tests were made for a material made of a copper. The finishing was carried out on in a Rollwasch SMR-D-25 vibratory tumbler. The surface of the finished objects was examined with a Nikon MA100 microscope equipped with a NIS-elements viewer (version 4.20). The surface texture of the finished elements was examined using a Taylor Hobson Talysurf CCI Lite optical 3D profiler. The effect of processing time on mass loss, mean changes in arithmetic surface roughness were determined.

Keywords: Vibratory machining, tumble finishing, tumbling, fine machining, burrs removing

1. INTRODUCTION

Modern technology development is associated with the emergence of modern construction materials and with them there is a need to develop methods used for their processing. Advances in materials engineering cause that currently manufactured materials are characterized by increasingly high strength properties, increased hardness, resistance to abrasion [1] etc. These materials are further characterized by a lower unit weight, high operating characteristics (including aggressive environments, elevated temperatures, etc.). High strength parameters, high hardness and resistance to wear mean that it is practically impossible or economically unjustified to process such materials with conventional methods [2]. In many cases, conventional machine tools were replaced with numerically controlled machine tools, in which the manual abilities of the employee were replaced by computer control [3]. The situation is similar in the case of finishing processes. Finishing processing are troubling element of the technological process, in many cases, require significant manual labor and the cost of these operations [4]. The situation is particularly interesting in the case of elements with complex shapes in mass production. The search for effective methods of finishing treatment has been reduced to the development of container processing - removing with loose abrasive media [5]. These are loss-processing, to achieve the desired roughness, smoothness of the surface of the workpiece. Very often they are used for deburring, rounding of sharp edges or for glossing the surface to a gloss effect. The authors proposed using vibratory machining with loose ceramic media.

2. METHODS

Devices for vibratory machining were introduced for common use in the 1850s, and thanks to improvements they became the basic construction of the industry [6]. The devices usually consist of a drive unit forcing the vibrating motion connected to the working container [7]. The tank mounted using spring susceptible to the fixed base. The movement of machining media is usually controlled by adjusting the engine speed. In the literature, you can find terms synonymous with the term "mass finishing" such as loose abrasive media treatment, container finishing, vibro-abrasive machining, and superfinishing [8]. Anglo-Saxon literature often uses the terms micro mass finishing, rotofinish, tumble finishing or vibratory tumbling [9]. Ceramic abrasive media are commonly used for the material-removing surface treatment [7]. The material-removing treatment with ceramic media, the unevenness of the work surface is removed as a result of abrasion of irregularities [10]. Objects processed as a result of the process, lose very little original mass. Ceramic abrasive media because of its destiny must have a specific machinability.

3. RESEARCH OBJECT

Test objects were made in the form of tube samples of copper alloy Cu-DPH (the chemical composition is 99.99% copper, and 0.015-0.040 is phosphorus) - **Figure 1**. Copper, deoxidized with phosphorus, has good electrical and thermal conductivity. It has a high corrosion resistance [11]. It is plastic and susceptible to cold flashing. Copper in this grade is used mainly in the automotive and construction industries, where it is used for roofing and architectural elements production [12], hence the need for finishing of objects made of copper.

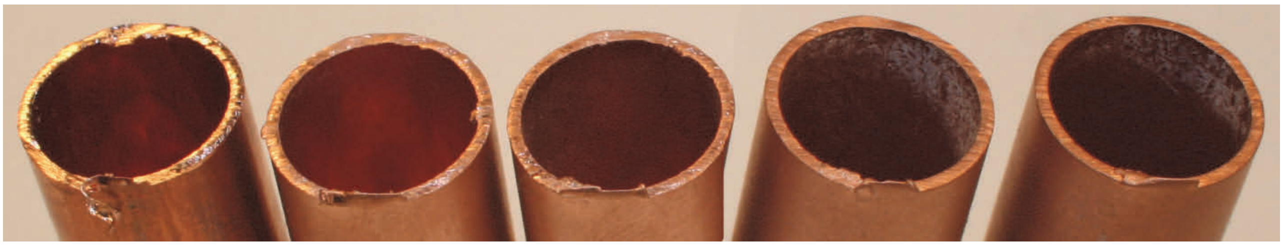

Figure 1 Workpieces processed for 0, 30, 60, 180, 300 minutes

The tests were carried out on vibratory tumbler an Rollwasch SMD-25-R. The objects of tests were subjected to treatment of deburring using ceramic media CB 20T- **Figure 2**. It is designed for roughing and deburring processes. The duration of deburring was 5, 10, 30, 60, 120, 180, 240, 300 and 1000 min. The frequency of the vibration tumbler was set 2600 Hz. Deburring processes were carried out on wet add approx. 150 ml liquid adjuvant ME L100 A22/NF.

Figure 2 Ceramic media CB 20T

4. RESULTS AND DISCUSSION

Before tests, the workpieces were marked and weighed. Then, they were placed in the tumbler and processed for 5, 10, 30, 60, 120, 180, 240 and 300 minutes. Moreover studies have been complemented by 1000 minutes wibratory machining. After the finishing process, the tests objects were weighed again, in order to calculate the mass loss. The relative mass loss (MMR), expressed in ‰, was calculated from the mass loss relative to the mass (of the part) before the smoothing operation [13].

In addition were measured the length - l, and thickness - g of burrs formed after cutting with a band saw. In professional literature, the bar is sometimes defined as "sharp performance on the surface formed after machining or grinding". According to ISO 13715 [14] a burr is an external deflection of the material from the nominal shape of the outer edge.

Table 1 Material removal rate (MRR), burrs measurements and the surface texture parameters.

Processing time, min	Weightloss, MMR, g	Weightloss MMR, ‰	l, mm	g, mm	Sa, µm	Sz, µm
0	0	0.00	3,122.69	1,092.91	0.188	10.851
5	0.0048	0.30	3,696.39	848.73	0.27	10.587
10	0.0161	1.02	2,814.15	911.2	0.312	10.361
30	0.0182	1.14	2,689.04	864.9	0.339	9.445
60	0.0273	1.71	3,095.17	823.44	0.346	8.429
120	0.0435	2.72	2,775.03	769.04	0.336	8.523
180	0.0554	3.48	2,689.59	717.74	0.344	8.358
240	0.0657	4.13	3,207.26	616.78	0.353	8.535
300	0.0789	4.95	2,400.66	386.9	0.349	7.687
1000	0.1746	11.06	0	59.91	0.315	7.569

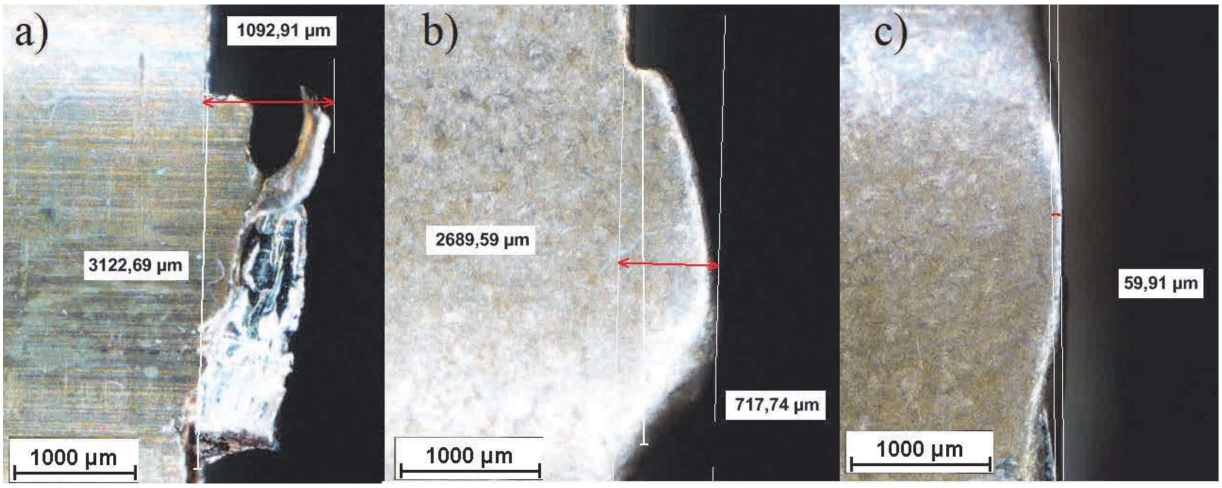

Figure 3 Scheme for measuring the length of burrs - l, burr thickness - g, a) initial condition b) after 180 minutes of vibro-abrasive treatment, c) after 1000 minutes

The authors focused only on the first stage of container processing - roughing - deburring. In order to obtain polished surfaces, the second stage should be applied with the use of polishing media, eg porcelain or metal. It will then be possible to polishing and shine the workpieces surfaces. Roughing allowed to remove burrs from previous machining operations - band saw cutting. Confirmation of this statement is **Figure 3**, showing how the basic dimensions of burrs change with the duration of treatment. The samples before processing had a burrs length of about 4 mm and a thickness of about 1.1 mm. As a result of vibratory machining with ceramic media for 1000 minutes, the burr practically does not occur. Observations under the optical microscope only reveal that the edges are rounded, and in the place where there was a burr after cutting, we can observe a negligible residue after the work. The measurements made revealed that thickness of burr it has approx. 60 µm.

The measurements of the geometric structure of the surface were carried out using an Taylor Hobson Talysurf CCI Lite optical 3D optical profiler. According to Janecki [15] defined the 3D area surface texture parameters, Sa is the arithmetic mean height of the surface. Parameter Sz is the maximum height of the surface. Parameter Sv is the maximum height of valleys. And parameter Sp is the maximum height of peaks (difference between Sz and Sv) [15]. The results of measurements for different tumbling times of the basic surface roughness parameters are included in **Table 1**. The results indicate that there is almost a linear relationship between the tumbling time and the mass loss. However, the steepest portion of the mass loss to tumbling time curve corresponds to the initial period of the finishing process (10 minutes). For longer times, the increase in the mass loss rate is linear (**Figure 4 a**). The 3D surface roughness maps - **Figure 5**, show that an increase in the tumbling time leads to a increase in surface roughness, from approx. 0.19 microns (initial state) to approx. 0.34µm (300 min vibratory machining) - see also **Figure 4 b)**.

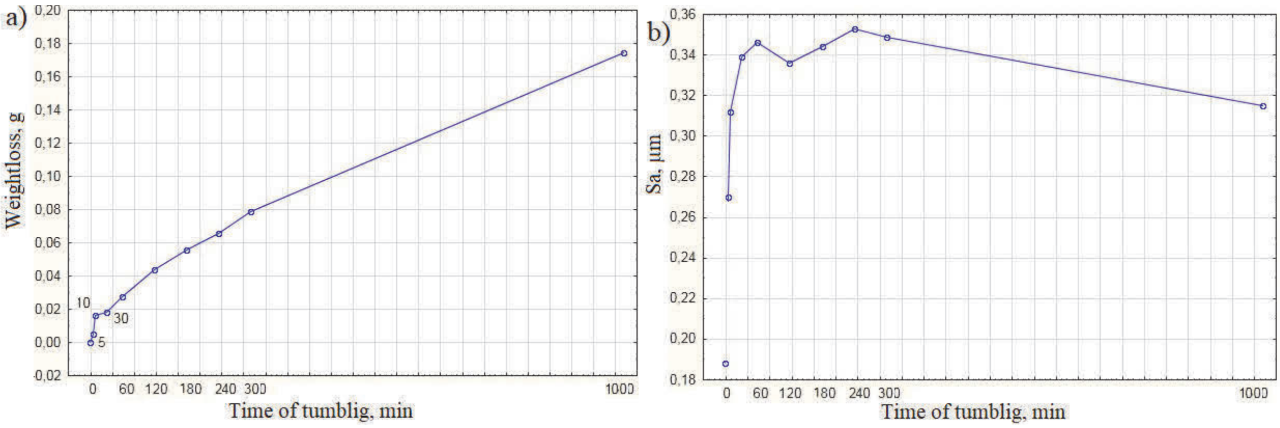

Figure 4 a) Rate of material removal versus tumbling time,
b) dependence of the arithmetic mean height of the surface- Sa, versus tumbling time

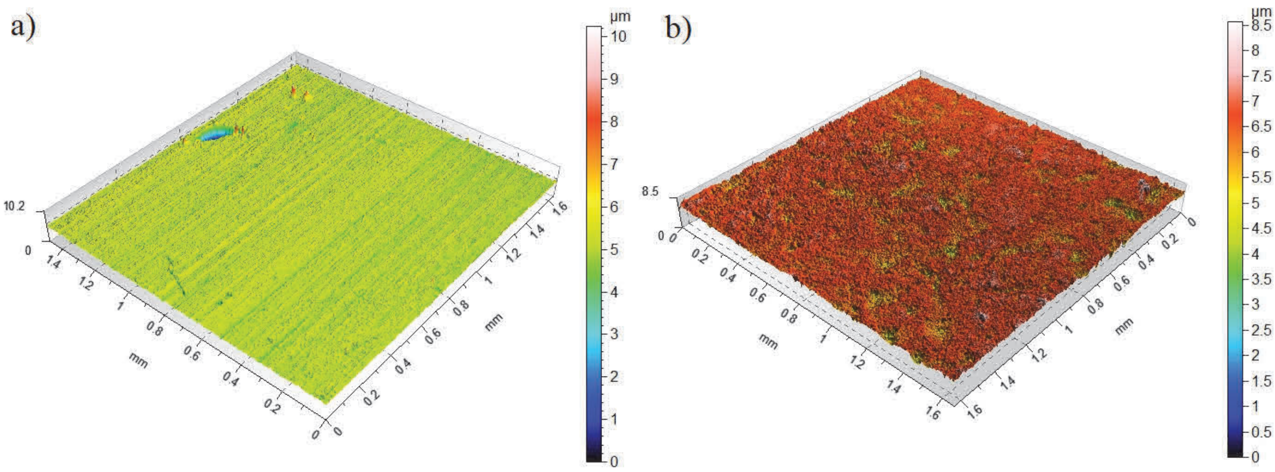

Figure 5 3D surface texture of copper a) before and b) after 1000 min of vibratory machining (Taylor Hobson Talysurf CCI Lite optical 3D optical profiler)

Based on observation on a Nikon MA200 optical microscope, it can be confirmed that the treatment with loose fittings allows to obtain isotropic surfaces - **Figure 6**.

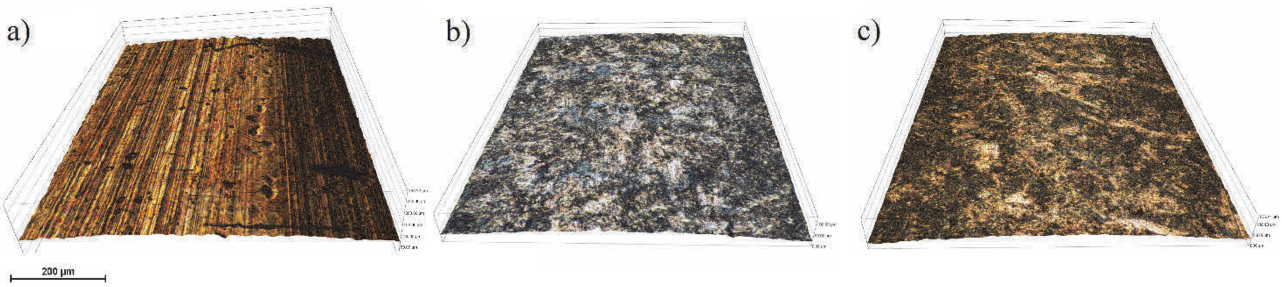

Figure 6 3D surface texture of copper a) before and b) after 60 min and c) after 1000 min of vibratory machining (Nicon Nikon MA 200 Eclipse)

5. CONCLUSION

Based on the research it can be stated that the processing with loose media - vibratory machining, obtain for isotropic surfaces.

After the use of ceramic media in order to achieve smaller surface roughness, it is recommended to use media dedicated to polishing processes (steel balls, porcelain media).

Vibratory machining is an excellent technology that allows deburring and edge rounding. By using ceramic fittings it is possible to completely remove burrs for copper alloys after 1000 minutes of treatment. The use of other abrasive media and a higher vibration frequency of the tank can reduce processing time.

With the increase of the vibratory machining time, Sz decreases from approx. 11 μm to approx. 7 μm, after 1000 minutes of machining.

With the increase of the vibro-abrasive machining time with ceramic media, the arithmetic average surface roughness - Sa, rises from approx. 0.19 micrometers (initial state) to 0,34μm after 30 minutes. Vibratory machining after 30 minutes reaching a stabilized value, further processing reduces the difference between the highest peak and the largest recess.

Carried out long-term tests using ceramic media confirms that this type of media is designed to the first stage of finishing treatments - deburring.

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