

## Analysis of the effect of processing vibro-abrasive finishing on the ammunition scales topography surface and sharp edges

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### ABSTRACT

**Purpose:** The paper presents a comparison of the effects the processing time vibro-abrasive deburring and polishing process on the structure of the geometric surface. There is also analyzed the relationship between the duration of the treatment on the quality of sharp edges.

**Design/methodology/approach:** Following the tests, the surface roughness and waviness of the machined job were measured by using optical profilometer Talysurf CCI Lite - Taylor Hobson. To illustrate the surface taper ratio and edge optical microscope Nikon MA 200 Eclipse with the image analysis system NIS 4.20 was used. Smoothing vibratory was carried out on the machine SMR-D25, which is discussed in study.

**Findings:** Two types of treatment were analyzed by using a vibro-abrasive deburring and polishing. The first vibratory process - dry deburring was performed by using ceramic media CB 0815 VH Series. The degree of aggressive of ceramic given by the manufacturer is 24%. The second process- the vibration-surface polishing was performed by using the fittings with white porcelain series EB 0610. The process was carried out by using liquid supportive Series ME L100 A22/NF.

**Research limitations/implications:** Analysis of the vibration smoothing technology in terms of technical refers mainly to compare the results of the geometric structure of the surface.

**Originality/value:** The 3D analysis of the surface topography for all samples was carried out. Deburring and polishing processes were compared.

**Keywords:** Fine machining; Superficial layer; Surface roughness; Vibration machining; Vibro-abrasive; Rotofinish; Tumbling

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### MANUFACTURING AND PROCESSING

## 1. Introduction

Vibro-abrasive machining, in a technical sense is the process based on a chemical-mechanical [1] surface finish treatment using, as a medium machining profiles shaped abrasive [2]. The principle of operation vibro-abrasive machining apparatus shown in Figure 1. Machining process with loose abrasive may be used in different varieties of kinematic, for example vibro-abrasive machining (also referred to as a vibration machining), drums etc. [1]. The nomenclature of English are also used to determine tumbling or rotofinish. The described type of treatment is widely used in jewellery polishing metal jewellery for polishing plastic components [3], natural bone and precious stones as well as deburring and degreasing processes as well as in the manual elaboration of ammunition to clean previously used scales.[4]

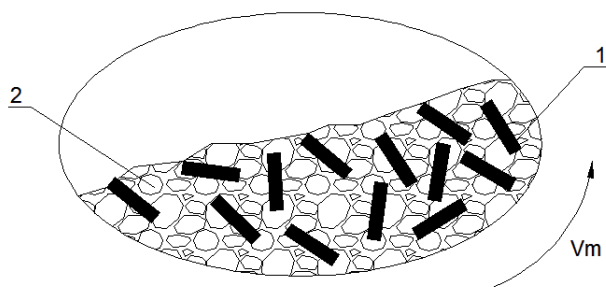


Fig. 1. Process flow diagram of the vibratory treatment: 1) shaped abrasive, 2) workpieces,  $v_m$  – the direction of movement of charge [5]

### 1.1. Parameters of vibro-abrasive machining

Before proceeding to any treatment we need to know what we want to get the final result, so it is necessary to specify the conditions of the process, such as [6,7,8]:

- the type, shaped, level of abrasive (grinding and/or polishing) of media used
- supporting cutting fluids and/or pastes,
- treatment time;
- frequency of operation,
- an appropriate proportion of the media and machining workpieces,
- the time and manner of separation (separation of the media from objects),
- the type of granule drying.

### 1.2. Advantages of vibratory processing

The greatest opportunities offered for vibration machining it brings with loose abrasives are [3,9]:

- blunting sharp edges of objects – deburring, rounding sharp edges,
- removal of oxide layers, scale,
- a reduction in surface roughness,
- homogenise the geometric structure of the surface of the object,
- preparation of the surface of objects to the application of galvanic coatings
- improve the surface reflectivity (lightening),
- cleaning of the surface,
- removal of burrs, burrs, etc.,
- smoothing,
- strengthening of the surface layer (as a result of burnishing),
- change in residual stress after heat treatment and welding operations and call density of the surface layer [3],
- the introduction of compressive stress and increasing the hardness of the surface layer.

The shape and size of roughness a large extent depend on the operational properties of the surface: abrasion resistance [7,9], suitability for carrying the burden of fixed or variable and, corrosion resistance [8]. The surface roughness also has a significant impact on the flow resistance, which is a very important factor everywhere should ensure fluid movement relative to the surface of solids [10,11]. The increase in roughness also increases the noise of flow around moving bodies at the resort, which facilitates the detection of hydro-location bodies immersed in fluid.

Figure 2 shows a schematic of the vibratory machine company RollWash of selected elements of the device. The main elements of the machine are:

- Abrasive media tank with a capacity of 25 litres, comprising a lid (5) and, the upper part of the tank (4) bolted to the bottom (3),
- A vibration motor (2) which is rigidly bolted to the tank and flexibly to the base of the machine (1) by means of suspension springs (15) and,
- Steel base machine,
- Inverter (6), which controls the vibration motor.

## 2. Subject tests

The study used scales made of brass (67% copper), diameter 7.62 mm, length 51 and 39 mm. Longer skins were pre-treated skins – deburring. Shorter skins were deburring and polishing.

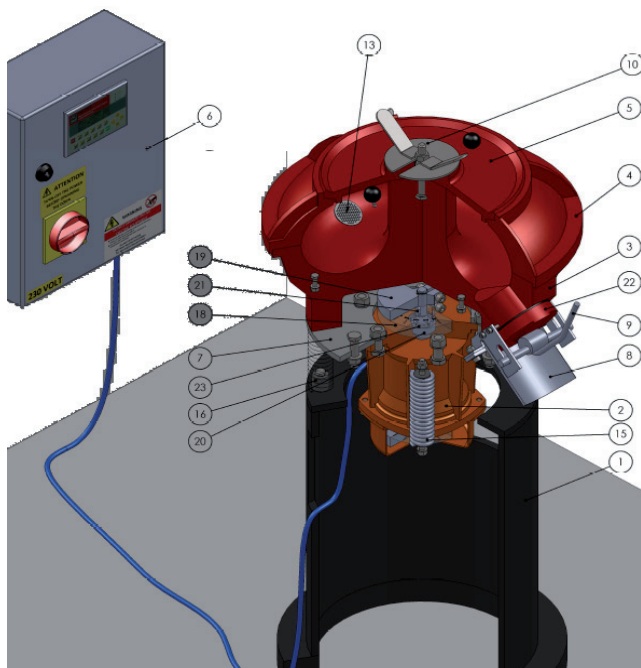


Fig. 2. 3D Model of vibratory machine RollWash SMR-D25

The first step in vibro-abrasive machining process was dry deburring surface with the use shaped ceramic media series CB 0815 VH in an amount of 25 kg. The degree of aggressiveness of ceramic media given by the manufacturer is 24%. The study was conducted in machine SMR-D25 container with a capacity of 25 litres containing the feedstocks of 25 kg machining medium and coats ammunition made of brass (67% copper). The duration of treatment was approximately 60, 120 and 180 minutes (Fig. 3). The frequency of vibration of the container is set to 3000 Hz.

The next process was cleaning and polishing the surface. It was conducted using the shapes of porcelain white Series VZ EB 0610 in the amount of 25 kg. This medium is dedicated to working polishing (superfinish). The process was carried out using liquid booster Seri FEL 120-B32. During the tests a container containing a machining medium of 25 kg, 50 grams of the fluid supporting and the mantle of ammunition scales after preparation deburring made of brass (67% copper). The duration of treatment was also suitable 60, 120, 180 min.

### 3. The study of the surface topography of the scales after treatment vibro-abrasive

#### 3.1. Analysis of the results of the 2D

The outlines of roughness and waviness profiles were examined in the Department of Mechanical Technology and Metrology with the use contact profilometer Taylor Hobson Form Taysurf PGI 1200. As a result of the experiment obtained samples with processing times of 60, 120, 180 minutes deburring and then also successively smoothed and polished at 60, 120 and 180 minutes.

During the study determined CutOff filter (Gaussian filter) to 0.8 mm. While measuring length was 4 mm. The measurements were performed for selected at random piece. Thus, for each of a series one sample represents the results of whole series, such as change the geometrical surface structure parameters. The resulting data from TalyProfile Gold allow a graphical representation of the test surface and automatically determine the roughness parameters.

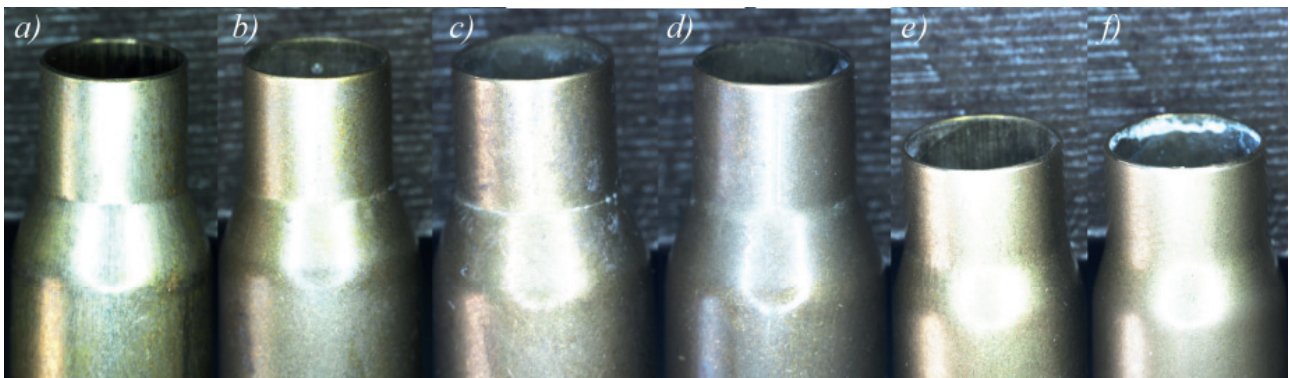


Fig. 3. Ammunition scales, a) in the state immediately after the drawing process, b) after deburring 60 min, c) deburring 120 min, c) deburring 180 min, e) smoothing and polished for 60 min, f) smoothing and polished for 120 min

When looking at Figure 4, we have already observed to get after 3 hours deburring and polishing processes to achieve a surface devoid of many drawbacks, which we observe as a curve close to the line (Figure 4 b). Resulting from the measurements characterizing data used to prepare graph depicting the surfaces a) and b) roughness  $Ra$  and  $Rt$  depending on the function of treatment duration

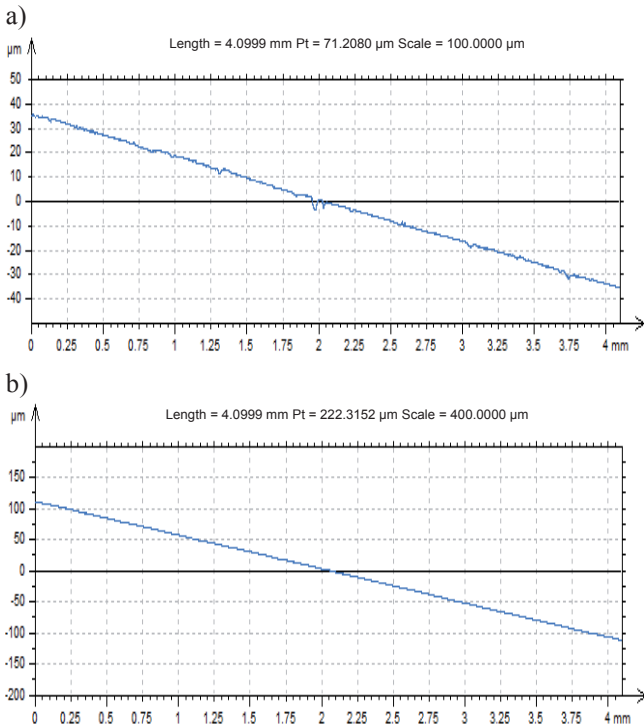


Fig. 4. Outline of the surface of the shell casing a) initial state (before machining) b) after finishing process (deburring 180 minutes and polishing 180 minutes)

Before conducting the experiment were expected to receive the positive effect of a significant reduction in surface roughness of machined by this method [12]. Analysing graphs 4 we can conclude that these assumptions are met.

It was also possible to analyse the influence of the time and type of machining on the roughness. We can conclude that with increasing deburring treatment time average surface roughness  $Ra$  decreases from  $0.416 \mu\text{m}$  to  $0.177 \mu\text{m}$ . However, for polishing  $Ra$  decreases from  $0.339 \mu\text{m}$  to  $0.177 \mu\text{m}$  after 180 minutes. On the basis of Fig. 5a we see that we obtain better results for the treatment of polishing. Considering the roughness parameter  $Rt$  (the difference between the highest and the lowest measured point) for deburring the  $Rt$  decreases from  $4.70 \mu\text{m}$  at baseline to

$2.58 \mu\text{m}$  after 180 minutes of treatment. The results obtained in presence deburring suggests of a large error in the case of a sample treated for two hours. But also deburring process reduces the nearly twice the difference between the highest and lowest measured point For polishing processing parameter  $Rt$  in the original state was  $5.41 \mu\text{m}$  and for polishing at 180 minutes fell three times to  $1.79 \mu\text{m}$ . Longer treatment times allow to obtain lower roughness parameters. Better results we obtain roughness parameters for polishing than for deburring which is confirmed by Figure 5 a) and b).

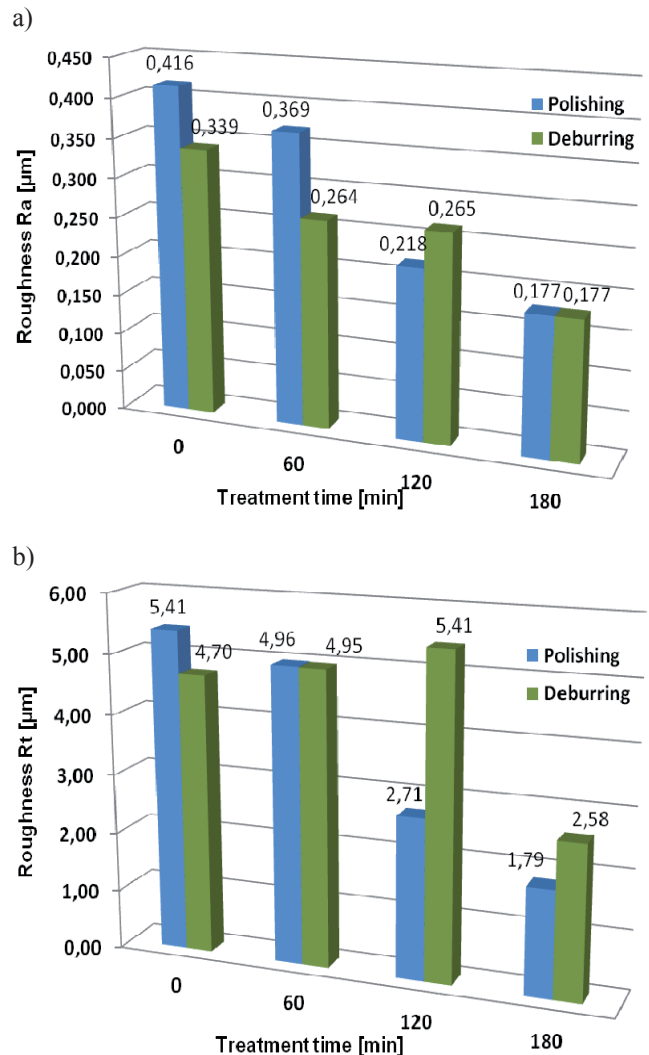


Fig. 5. a) The surface roughness  $Ra$  versus the type and duration of vibro-abrasive machining b) The surface roughness  $Rt$  depending on the type and duration of vibro-abrasive machining

#### 4. Analysis of the results of the 3D surface roughness

The outlines of 3D surface topography, we investigated on the optical profilometer Talysur CCI Lite Taylor Hobson. Number of measurement points amounted to 1024x1024, while resolution in axis X-Y with a 50 times magnification is 0.33  $\mu\text{m}$ .

As a result of observation we can conclude that on the surface mantle of scales are visible arranged irregularly oriented features in a totally random directions (Fig. 6). It can be seen by the human eye or by using a magnifying glass. It is probably already defective material they were made coats of ammunition scales. It is therefore important to ensure appropriate intermediates of detail which will be executed when we want to adequately smooth surface free of defects from manufacturing step already [11].

Performance of the analysis 3D of scales ammunition surface treated in vibrant containers can say that as a result of processing the samples for 120 minutes gave the arithmetic mean height of the surface  $S_a$  is of 0.3019  $\mu\text{m}$ , which for the sample in the initial state was 0.3454  $\mu\text{m}$  (Fig. 7). Considering the geometric structure of the surface must also mention the roughness parameter  $S_q$  which for scales was not treated is 0.5653  $\mu\text{m}$  while for the treatment of deburring 120 min and polishing 120 min decreased to 0.4172  $\mu\text{m}$ . Also important parameter, which was a reduction in the above-mentioned conditions is the maximum surface height from 13.3989  $\mu\text{m}$  to 7.5697  $\mu\text{m}$ . Drawn up in the program outline of the surface in polar coordinates show a more uniform course of a chart when the polishing process for two hours than the scales immediately after the drawing process.

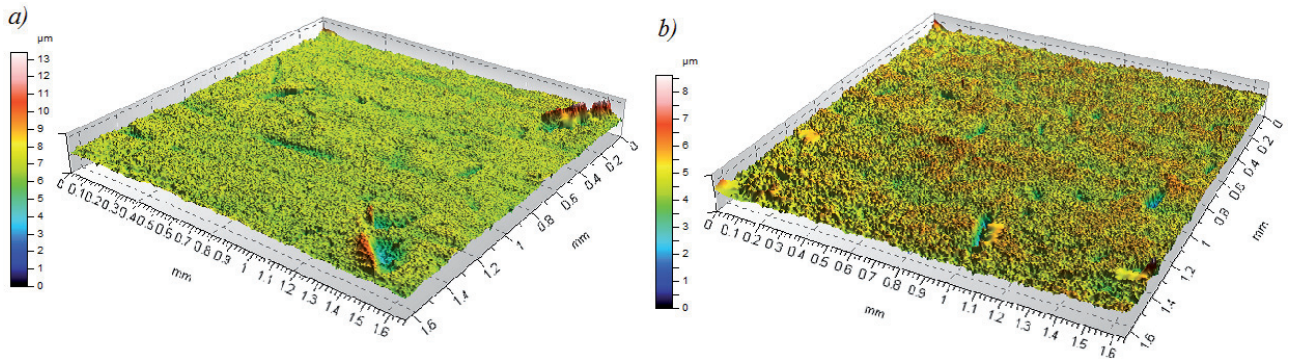


Fig. 6. 3D surface topography a) scales 7.62x39 mm in initial state b) scales 7.62x39 mm after deburring – 120 min and polishing – 120 min processes

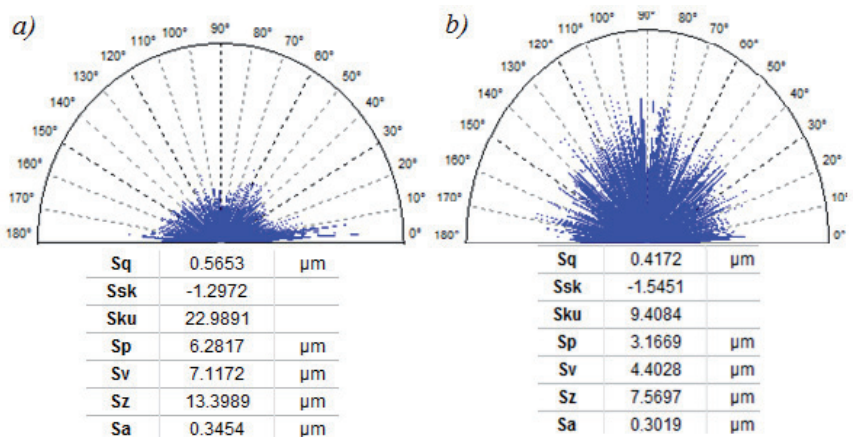


Fig. 7. The values of the structure parameters of 3D surface a) scales in the initial state (past plastic forming) and an outline of the surface in polar coordinates, b) scales after deburring of 120 minutes and polishing 120 minutes processes and an outline of the surface in polar coordinates

## 5. Conclusions

To conclude vibro-abrasive machining have positive effect on the surface roughness. In the case of higher requirements posed finishing surfaces be used longer machining times polishing.

Vibro-abrasive machining technology is the right solution refinishing process conditions and high volume production.

Vibro-abrasive machining method is an effective method and can fully replace the finish process small details carried out by conventional methods of files, tape polishing and polishing.

Small media (fittings) polishing that allow for rounding off sharp edges can block inside the small pieces items which occurred in single copies scales 7.62x39 mm. It's leads to in the results to deformation of the internal shape of the material. However it did not have affect the surface roughness.

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