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The Effect of Grinding on the Apparent Colour of the Powder

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ABSTRACT: *The particle properties size, shape and their distribution are amongst the decisive parameters which determine the behavior of powders for the application or further processing. Several materials are grinding: copper(II) sulfate pentahydrate, cobalt(II) chloride hexahydrate, brown rosin and yellow rosin. Colors of powders are related to the fineness of the powder, when the powder is illuminated with white light. With grinding, color of powder gets more light closer to white. Color changes can be studied by using RGB color model. It was found that decrease of the particle size leads to the increase of R, G and B values*

KEYWORDS: *powder grinding, color model.*

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I. INTRODUCTION

It is well known that grinding of colored material, in some cases, leads to a different color as compared to the original material. The relationship between apparent color of the powder and the particle size has a wide range of practical applications including: food production, paints, ceramics, the conservation and restoration of historical artifacts, in pharmacology and dentistry, etc. [1-7].

Generally speaking, powders represent disperse systems of a solid disperse and a gaseous phase. Depending on the particle size, one may distinguish 'fine grain' with dimensions smaller than 1 □ m, 'medium grain' with dimensions between 1 and 10 □ m and 'coarse grain' with diameter of particles greater than 10 □ m [8]. The dimension of the particles determines smoothness, gloss and uniformity of the powder. Powders consisting of coarse grain particles induce very saturated color but have poor hiding power unlike those with fine grain, which instead have greater hiding power [9]. In powders consisting of larger and irregular particles, the light easily penetrates through the different paint layers, and then, the contribution of the support to the light reflected is greater. On the other hand, very thin and homogeneous grains provide good hiding power, but little tinting strength.

Knowledge of particle sizes and the size distribution of a powder system is a critical step in most production and processing operations [10]. Particle size and size distribution have a significant effect on the mechanical strength, density, electrical and thermal properties of the finished object. The consequences of improper size analyses are reflected in poor product quality, high rejection rates and economic losses.

In this paper we have studied the color changes due to grinding of: copper(II) sulfate pentahydrate, cobalt(II) chloride hexahydrate, brown rosin and yellow rosin. Grinding powder is passed through a sieve of different mesh. The color of powders were analyzed by using RGB (Red, Green, Blue) color model [11]. The dependence of the RGB values on the diameter of particles are plotted.

II. METHOD

Powder size and size distribution can be determined using numerous methods and instruments [12]. Granulometric analysis of powders can be carried out using sieving [13]. During sieving the sample is subjected to vertical movement (vibratory sieving) or horizontal motion (horizontal sieving). During this process the particles are compared with the apertures of every single sieve. The probability of a particle passing through the sieve mesh is determined by the ratio of the particle size to the sieve openings, the orientation of the particle and the number of encounters between the particle and the mesh openings.

The color of the specified powder depends on the variety, growing conditions, dehydration, storage conditions and powder coarseness [14]. However, the personal perception of color varies in dependence of the sensitivity of the eye, the size of the object being viewed, background color, illumination, etc. Since the verbal description of color could be difficult and confusing, a model that is most commonly used for color measurements is the RGB (Red, Green, Blue) model [11].

The RGB model (Red, Green, Blue) color model is the most known and defines a color by giving the intensity level of red, green and blue light that mix together to create a pixel on the display. With most of today's displays, the intensity of each color can vary from 0 to 255, which gives 16,777,216 different colors.

In our studies, RGB analysis consists of: 1) taking single layer of granular material, 2) taking pictures, 3) determination of RGB values on different part of pictures (as shown in Figure 1) and 4) averaging RGB values for 5 different parts of pictures.

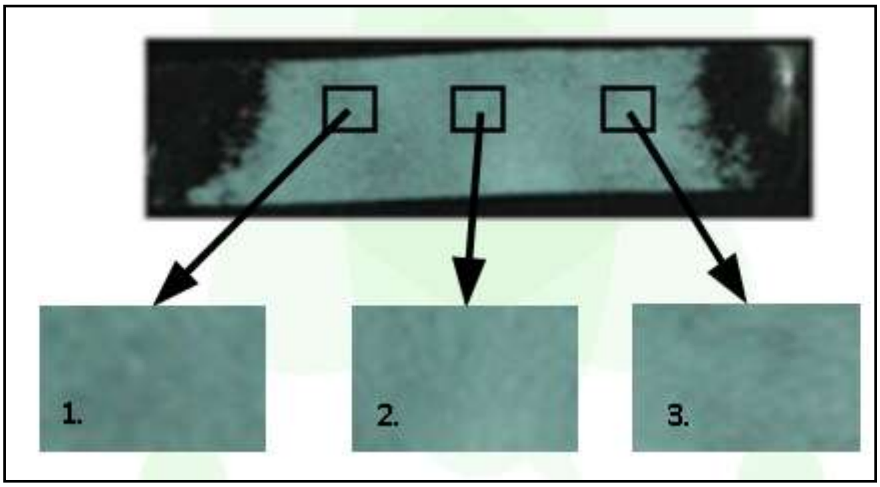
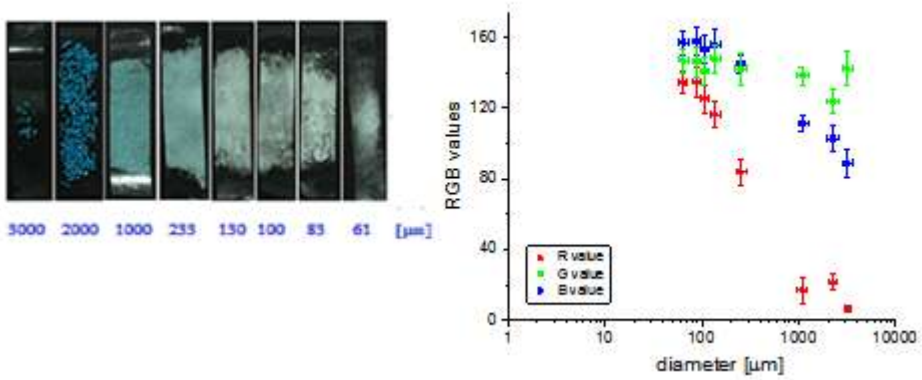


Fig.1. Different parts of powder sample subjected to RGB analysis.

III. RESULTS



.2. Grinding of copper(II) sulfate pentahydrate (left) and the corresponding dependence of the RGB values on the particle diameter (right).

Figure 2 shows how color of copper(II) sulfate pentahydrate changes with grinding. When the particle size are around 3mm, material is dark blues. With decreasing the particle's diameter, R, G and B values increase and the color is changes from dark blue to light blue. With further decrease of the particle size, R, G and B values become closer and the powder becomes lighter.

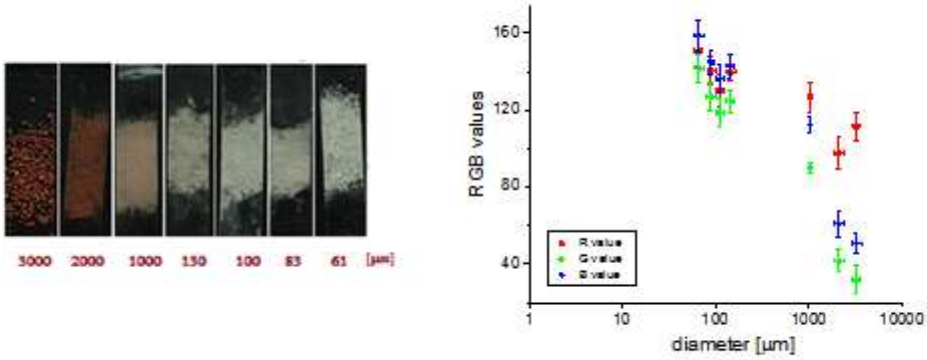


Fig.3. Cobalt(II) chloride hexahydrate (left) and the RGB values (right) depending on the particle diameter.

The same behavior can be observed when cobalt(II) chloride hexahydrate is grinding (see Figure 3). When particle's diameter is around 3mm, the material is almost dark red. In that case, R value is much larger than G and B values. As the particles become smaller, the contributions of G and B values are closer to R value and the powder changes colors via light red to almost white for the particle's diameter of around 60 microns.

Figures 4 and 5 correspond to the brown and yellow rosin, respectively. With grinding both materials R, G and B values increase and become closer. Also, powder composed of smaller particles is lighter as compared to the powder with larger particles.

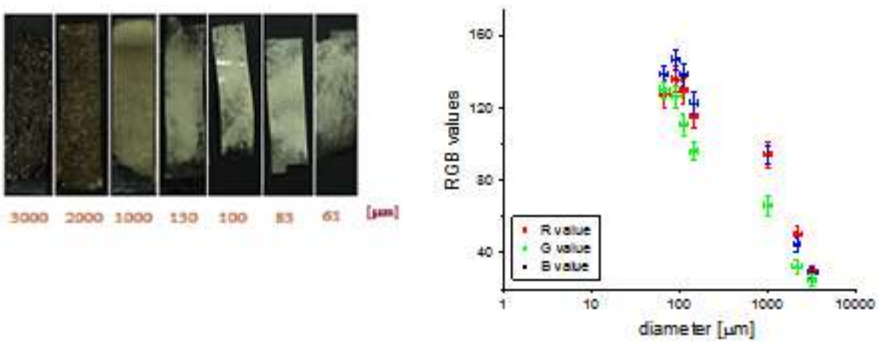


Fig.4. Brown rosin (left) and the RGB values (right) as a function of the particle diameter.

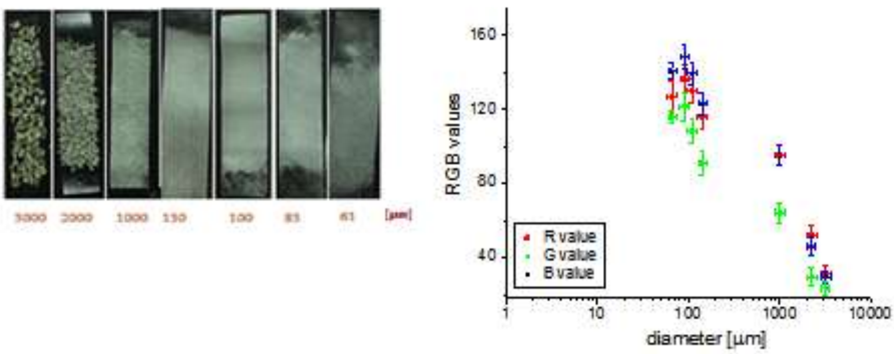


Fig. 5. Grinding of yellow rosin (left) and the corresponding dependence of the RGB values on the particle diameter (right).

IV. CONCLUSIONS

This paper reports on our studies how the degree of grinding affects the apparent color of the powder. Several materials are considered: copper(II) sulfate pentahydrate, cobalt(II) chloride hexahydrate, brown rosin and yellow rosin. Materials are grinding and sieving through different meshes. Colors of powders are related to the fineness of the powder and depends much on the variety, growing conditions, dehydration and storage conditions, and powder coarseness as well. By grinding, it can be monitored and visually defined by the fineness of the powder Color changes can be considered using a color model. It was found that with decreasing of the particle size, R, G and B values increase and become closer. The present work is the result of solving one of the IYPT 2018 problems. This work has also been supported by Ministry of Education, Science and Technology Republic of Serbia O171036 project.

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