NANO - APPROACH OF PAINTING CONSERVATION

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Abstract: *The study of nanostructured materials is considered an emerging field for the next years. To advance the field of preservation of cultural heritage science and nanostructured materials there is a continuous interdisciplinary collaboration between material science specialists and preservationists. In this work we present a complex study of preparation of nanomaterials based on $Ba(OH)_2$, material used for conservation of a painting from a private collection. Is also presented a comparison between the effects of commercial materials and nanosized synthesized materials.*
Keywords: *nanomaterials, painting restoration, barium hydroxide*

1. INTRODUCTION

Due to the fact that paintings have been cultural expressions of human creation throughout history, their deterioration, accidental or intentional destruction constitutes a loss affecting a significant part of the world's cultural heritage, that's why it must be an interdisciplinary approach to save the legacy.
Chemical degradation, which induces the flaking of paintings and deterioration from rain, wind, dust, and other environmental causes, is mainly responsible for the weakening of the porous structure and the surface layers of the materials used in works of cultural heritage. In these situations, restoration is essential to the works of art [1-3].
Applications of nanotechnology to wall paintings consolidation and paper deacidification have recently provided clear evidences of the huge potentiality of this emerging science for cultural heritage conservation [4-7]. Historically, the Ferroni-Dini method, also called the "barium" method, was the first method that provided reliable results and its success was mainly related to the possibility of removing salts that threaten the paintings, reinforcing at the same time the porous structure [8-10]. The whole physico-chemical compatibility between the original and the restoration materials can be completely achieved by using the proper material [11-14].
Although many techniques were developed to obtain the synthesis of these particles is still difficult to perform a "perfect" restoration. Application of nanotechnology for strengthening and deacidification of paper were the first important steps in developing this part of science, most important nanomaterials used in this area are derived from calcium hydroxide and magnesium carbonate [15-20].

2. EXPERIMENTAL

2.1 Materials

In this study we have used barium hydroxide in commercial form (Chimreactiv, Romania) dissolved in water. For the synthesis of nano-sized barium hydroxide, the commercial hydroxide was calcinated into barium oxide at 1000˚C for two hours.
The oxide was refluxed with water and isopropylic alcohol for one hour under vigorous steer.

2.2 Characterization

Measurement of particle size and Z potential by dynamic light scattering (DLS) was performed with Malvern Nano ZS (RED BADGE) equipment. Analyses were performed in a state of colloidal dispersion in isopropylic alcohol, field device for measuring the particle size is 0.6 nm - 6μm; field for zeta potential: 5 nm - 10μm.

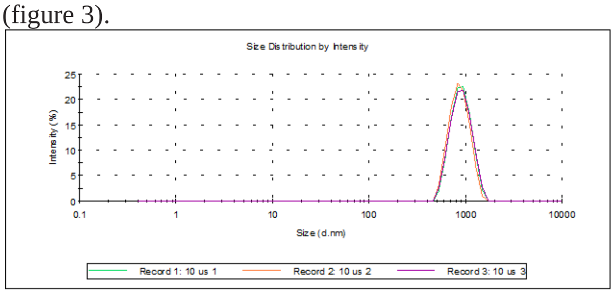
3. RESULTS AND DICUSSION

This study was performed on a painting from 1965, part of a private collection, painting presented in figure 1.
The method used for conservation is based on Ferroni-Dini method.
For the first experiment, we have used solutions obtained from commercial reagents. They were not effective in this condition, causing bleaching phenomenon of painting, especially visible on the surface of a red flower (figure 2).
The red flour in figure 2 treated with commercial barium hydroxide is clearly showing signs of bleaching being a good example on how **not** to perform a conservation/restoration on paintings.
We have considered that the particle size of barium hydroxide produced the unwanted appearance of the pigment, so the research was conducted towards the use of nano-sized barium hydroxide.

Figure 1. The 1965 painting used in the study

Figure 2. The experiment conducted with commercial barium hydroxide. The bleaching is visible.

The obtained barium hydroxide was analyzed by DLS (figure 3).



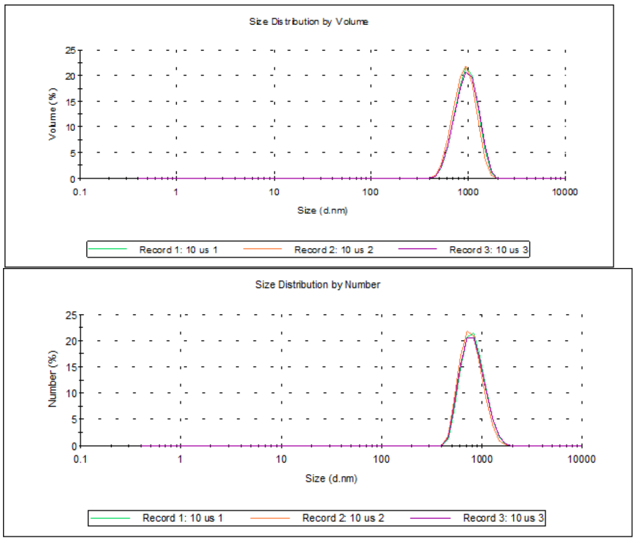


Figure 3. DLS measurements (by intensity, by volume and by number) for the synthesized material.

From the DLS measurements, it can be drawn the conclusion that the nanoparticles tend to aggregate, thus forming structures with sizes around 1000 nm.

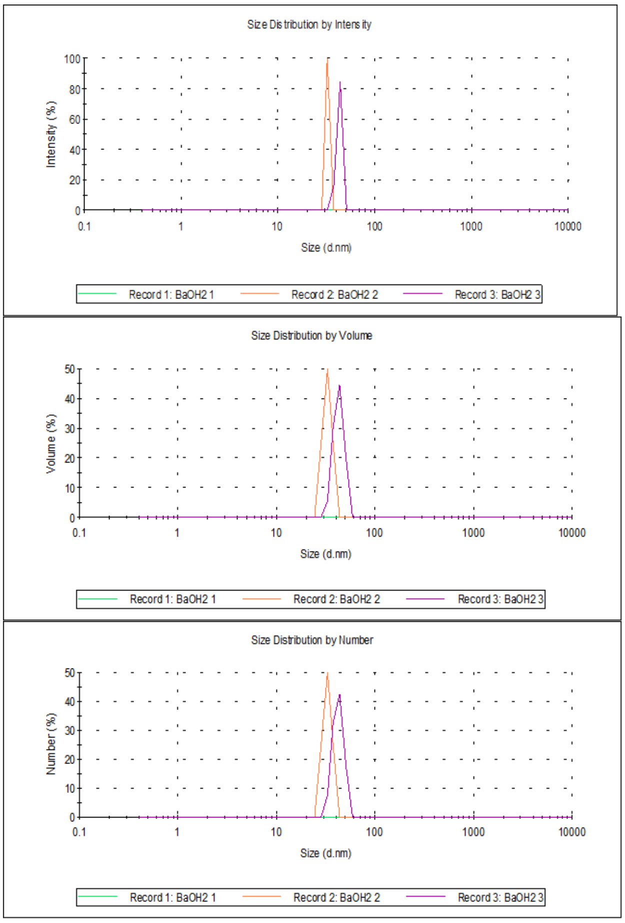


Figure 4. DLS results (by intensity, by volume and by number) for the $Ba(OH)_2$ nanoparticles decanted for 3 hours – liquid phase

Even though this size is considerable smaller than the size of the commercial reagent, we tried to collect some nanoparticles with sizes as small as possible.

For this reason, the solution was decanted for 3 hours (DLS results are presented in figure 4) and for 24 hours (DLS results are presented in figure 5). The liquid phase was collected and analyzed.

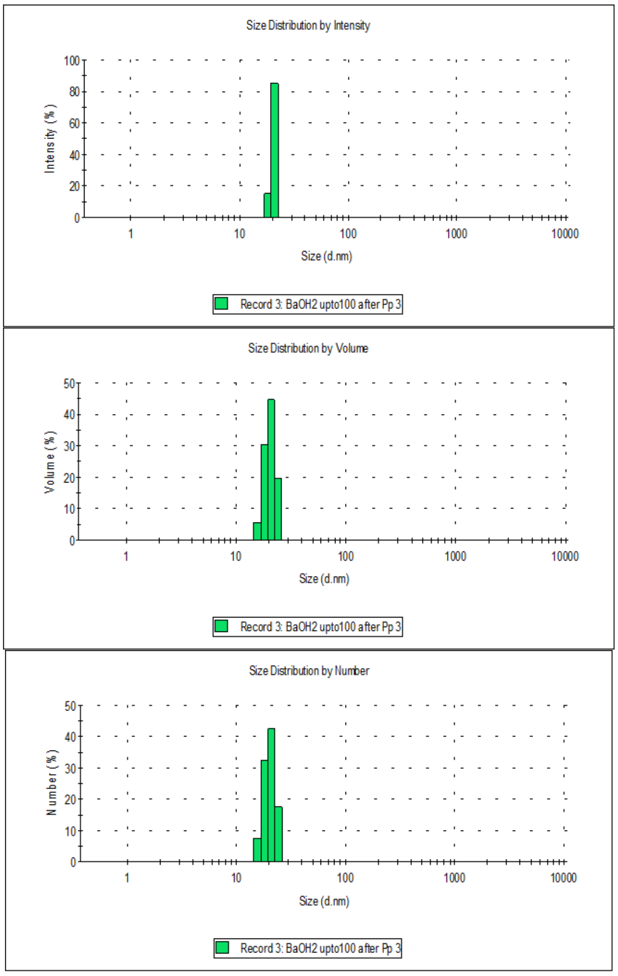


Figure 5. DLS results (by intensity, by volume and by number) for the $Ba(OH)_2$ nanoparticles decanted for 24 hours – liquid phase

From figure 4 it can be observed that after 3 hours, particle size is about 50 nm (distribution by volume), confirmed by number and size distribution. After 24 hours of decanting (figure 5), both distributions (by volume and by number) of particles confirms that the sizes of the collected nanoparticles are about 30 nm.
The DLS results imposed the use of $Ba(OH)_2$ collected from the liquid phase of the solution decanted for 24 hours for the conservation experiments.
In order to perform the conservation experiments, the barium hydroxide was collected from the liquid phase, dried and after that dispersed in alcohol. The alcohol was used due to the fact that is rapidly evaporated, so the results are visible over a short period of time.
It can be visually observed that the cracks in painting were filled with barium hydroxide from the alcoholic dispersion and after the solvent was evaporated the color was brightened (figure 6).

The color of the red flour in figure 6 is clearly brighter than the other surrounding untreated flours, confirming the success of the experiment.

Figure 6. The restoration/conservation experiment conducted with nanosized $Ba(OH)_2$. The differences between treated (in yellow circle) and surrounding untreated red flowers are visible

4. CONCLUSIONS

Nanomaterials are used for conservation and restoration of paintings, because, once reached the nano scale, they may penetrate into cracks formed in the pigment and thereby stopping the degradation and intensifying the color.
The experiments conducted on the synthesis and use of the $Ba(OH)_2$ nanoparticles for the restoration and conservation of paintings showed promising results, by filling the cracks and forming an invisible but effective protective layer on the surface of the painting.

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