



## Simple Synthesis Method for Alumina Nanoparticle

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*Globally, the human population steady increase, expansion of urban areas, excessive industrialization including in agriculture, caused not only decrease to depletion of non-renewable resources, a rapid deterioration of the environment with negative impact on water quality, soil productivity and of course quality of life in general. This paper aims to prepare size controlled nanoparticles of aluminum oxide using a simple synthesis method. The morphology and dimensions of nanomaterial was investigated using modern analytical techniques: SEM/EDAX and XRD spectroscopy.*

**Keywords:** aluminum oxide, hydrothermal, nanoparticles, termic treatment

### 1. Introduction

Over 20 percent of the entire population lives in geographical regions with limited water resources. In this context there are required immediately measures to combat continue environmental degradation. Expanding the nanotechnology applications in this area can represent a viable solution. Many studies reported the beneficial effects of nanotechnologies over the wastewater efficiency, quality and cost compared with conventional methods. Moreover, the nanomaterials properties can be designed to overcome current limitations and increase its performance. [1-3].

Research on alumina or aluminum oxide nanoparticles have shown many different applications. It can be used as biomaterial [3] but also at wastewater treatment [9] are just a few of these.

This paper aims to obtain alumina with controlled nanoparticles size into a simple and efficient manner.

## 2. Material and methods

All used reagents and solvents were purchased from commercial sources (Merck, Fluka) and used without a further purification. The synthesis method selected was thermic treatment in hydrothermal media at high temperature and pressure.

## 3. Experimental

### *Synthesis*

From the plurality of obtained methods reported in literature [4-8] was selected the hydrothermal treatment for the synthesis of alumina nanoparticles from  $\text{Al}(\text{NO}_3)_3$  (0.62 g) and KOH (0.2 M, 0.36 g). The reaction mixture is maintained under stirring at room temperature for 10 minute. Then was introduced into an autoclave at 350°C and 1100 bars for 24 hours. The result mixture was filtrate and washed with deionised water to neutral pH. The solid white was calcinated at 900°C. X-ray diffraction and SEM/EDX analysis were used for the characterization of nanomaterial.

### *Characterization of aluminium oxide nanoparticles*

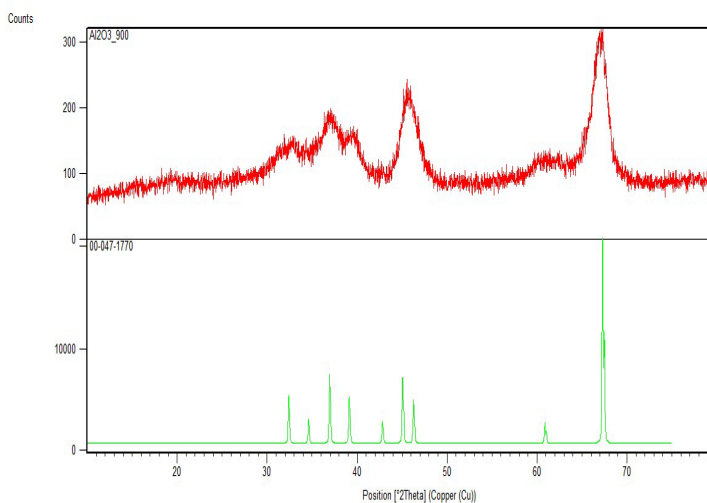
The crystallinity of the alumina nanoparticles was investigated by X-Ray diffraction (XRD) using PANalytical X'PertPRO MPD Diffractometer with Cu K $\alpha$  radiation  $\lambda = 1.5406\text{\AA}$ ,  $2\theta$ -step of  $0.01^\circ$  from 10 to 100. Scherrer equation,  $d = 0.9\lambda / (B \cos \theta)$  was used to estimate grain average sizes of crystallites, where B is the half height width of the reflection peak at  $2\theta$  and  $\lambda$  is the wavelength of the radiation. Scherrer equation,  $d = 0.9\lambda / (B \cos \theta)$  was used to estimate grain average sizes of crystallites, where B is the half height width of the reflection peak at  $2\theta$  and  $\lambda$  is the wavelength of the radiation.

*The morphology of obtained nanomaterials* was observed using an Inspect S PANalytical model scanning electron microscopy (SEM) using coupled with the energy dispersive X-ray analysis detector (EDX). The semiquantitative elemental analysis was analyzed through EDAX facility of SEM.

## 4. Results and discussion

### ***X-ray diffraction (XRD)***

Figure 1 show XRD patterns of nanomaterial. The presented results revealed the presence of corundum and monoclinic phases.



**Figure 1.** XRD pattern of alumina nanoparticles

### SEM-EDAX

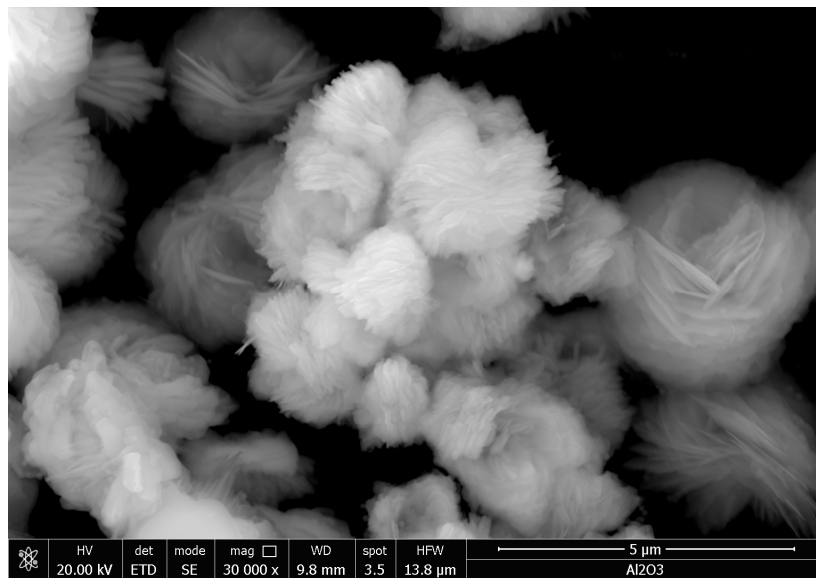
The results indicates that nanomaterial synthesized is pure since in EDX graph are found only specific peaks for aluminum and oxygen (Figure 2)



**Figure 2.** EDAX elemental analysis of alumina nanomaterial

From the SEM images (Fig.3.) can be observed the surface topography of sample. From the SEM images (Fig.3.) can be observed the surface topography of sample.

The obtained nanoparticles have regular geometric shapes which can be assimilated with spheres with diameters between 3 and 5  $\mu\text{m}$ . It can be considerate that formations agglomerated from the center of Figure 3 are assigned to coryndrum spheres with dimensions of which size is between 0.5-1  $\mu\text{m}$ . This indicates that, depending on the physical parameters (pressure and temperature) the size corundum nanoparticle can be controlled using this method of synthesis



**Figure 3.** SEM micrograph of alumina nanoparticles

#### 4. Conclusion

The present study investigates synthesis of nanoparticles of alumina with controlled size (smaller than 10  $\mu\text{m}$ ) using hydrothermal treatment. The morphological and structural analysis of nanomaterial obtained demonstrated the efficiency of the method. The properties (dimension) of nanoparticles thereby justifying further applied research and development of advanced material for sustainable water management.

## References

- [1] Petrea N., Iordache P.Z., Lungu R.M., Petre R., Pretorian A., *New methods and new types of functionalised nanocomposites intended for the ecological depollution of waters*, Nanocomposites, Ed. INTECH, 2011.
- [2] Qu X., Alvarez P.J.J., Li Q., *Applications of nanotechnology in water and wastewater treatment*, Water Research 47, 2013, pp.3931- 3946.
- [3] Rogoan R., Andronescu E., Ghițulică C., Vasile B.Ș., *Synthesis and Characterization of Alumina Nano-Powder Obtained by Sol-Gel Method*, U.P.B. Sci. Bull., Series B, Vol. 73, Iss. 2, 2011.
- [4] Tavakoli A.H., Saradhi Maram P., Widgeon S.J., Rufner J., van Benthem K., Ushakov S., Sen S., Navrotsky A., *Amorphous Alumina Nanoparticles: Structure, Surface Energy, and Thermodynamic Phase Stability*, Phys. Chem. C, 2013, 117 (33), pp 17123–17130.
- [5] Park Y.K., Tadd E.H., Zubris M., Tannenbaum R., *Size-controlled synthesis of alumina nanoparticles from aluminum alkoxides*, Materials Research Bulletin, Vol. 40 (9), 2005, pp. 1506–1512.
- [6] Mukherjee A., Sadiq I.M., Prathna T.C., Chandrasekaran N., *Antimicrobial activity of aluminium oxide nanoparticles for potential clinical applications*, Science against microbial pathogens: communicating current research and technological advances, A. Méndez-Vilas (Ed.) Formatex, 2011.
- [7] Piriya Wong V., Thongpool V., Asanithi P., Limsuwan P., *Preparation and Characterization of Alumina Nanoparticles in Deionized Water Using Laser Ablation Technique*, Hindawi Publishing Corporation, Journal of Nanomaterials, Vol. 2012, Article ID 819403.
- [8] Bhargavi R.J., Maheshwari U., Gupta S., *Synthesis and use of alumina nanoparticles as an adsorbent for the removal of Zn(II) and CBG dye from wastewater*, International Journal of Industrial Chemistry, 2015, Vol. 6(1), pp 31–41.

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