# Ultrasonic synthesis and characterization of $Zn_3V_2O_8$ nanostructures

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## Background

$Zn_3V_2O_8$ is important material in photoluminescence as anode material for lithium ion batteries [1] as efficient catalyst for selective oxidation of glucose to galacturonic, as materials for the sensing electrode which can be used to detect acetone (to 100 ppm) [2]. But $Zn_3V_2O_8$ is usually obtained from soluble salts by co-precipitation method [1] or from oxides by solid state synthesis [3]. Both of these methods are not eco-friendly. The first method requires a lot of water while the second one requires high temperature and don't lead to formation of nanostructure. We have studied the possibility formation zinc vanadate from oxides at ultrasonic treatment. Also zinc vanadate was synthesized by conventional solid state method for comparison.

## Ultrasonic synthesis

ZnO 2,86 g and $V_2O_5$ 2,14 g were loaded into a breaker and 80 ml of distilled water was added. Ultrasonic treatment was carried out USDN-A (УЗДН-А) frequency - 22 kHz at two different temperatures. First sample was synthesized at room (20°C) temperature and dried at 100°C and dried at 500°C. Samples were called ZnVO_20_100°C and ZnVO_20_500°C respectively. Second sample was synthesized at 80°C and was called ZnVO_80_100°C.

## Solid state synthesis

Comparison sample was prepared by conventional solid state synthesis ZnO 2,86 g and $V_2O_5$ 2,14 g were milled carefully and preheated at 600°C for 5h, again were milled carefully and were calcined at 750°C for 6h according reference [3]. Sample was called ZnVO_SS.

## XRD

Samples were synthesized by US method ZnVO_20_100°C and ZnVO_80_100°C have different colors. However, XRD were presented only patterns of $Zn_3V_2O_7(OH)_2(H_2O)_2$ without any patterns initial substances (Fig). After calcinations at 500°C (ZnVO_20_500°C) crystallization water was desorbed and **$Zn_3V_2O_8$** was formed.

XRD patterns sample ZnVO_SS show two phases are present: **$Zn_3V_2O_8$** and **$Zn_2V_2O_7$**. This fact can be explained high fugacity of ZnO at temperature higher 600°C.

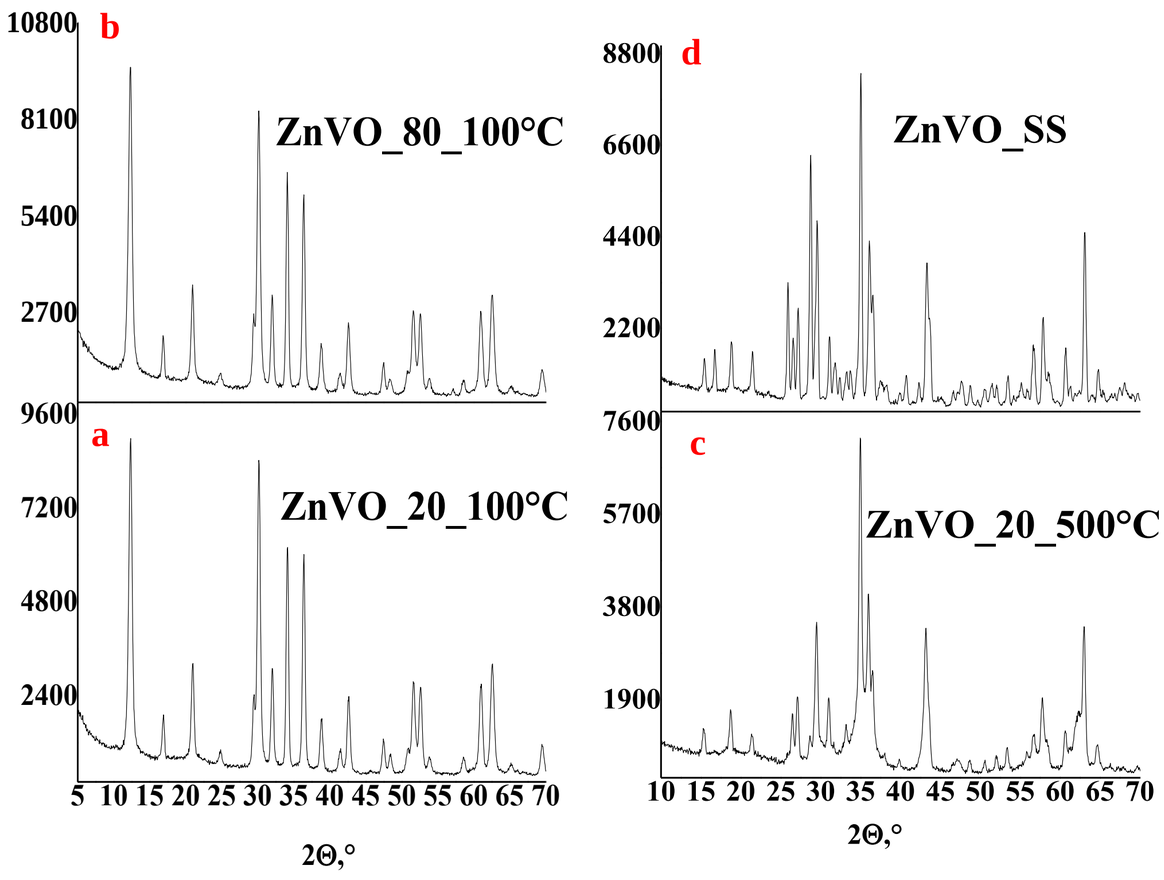


**Fig. 2. XRD data a) ZnVO_20_100°C, b) ZnVO_80_100°C, c) ZnVO_20_500°C, d) ZnVO_SS.**


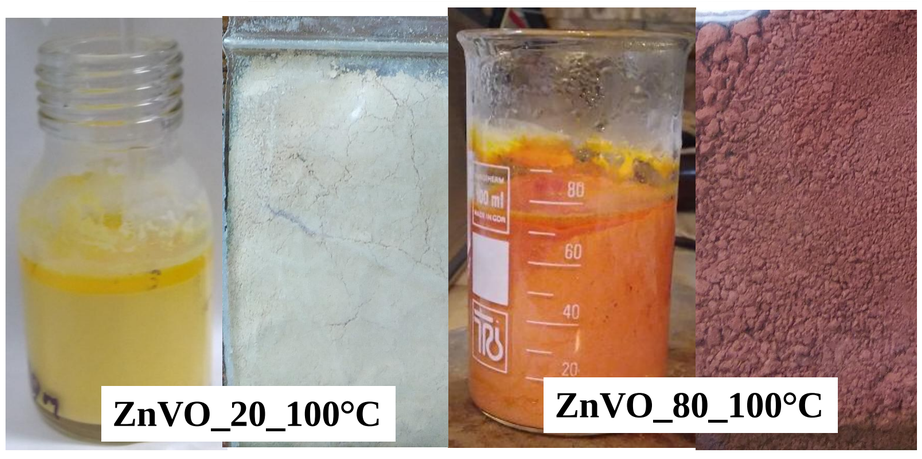


**Fig. 1. Photo of samples ZnVO_20_100°C and ZnVO_80_100°C**

## SEM, TEM, Specific surface area

The structures of zinc vanadates were obtained by ultrasonic treatment maximal similar to structure synthesized by conventional co-precipitation method from salts ($NH_4VO_3$ and $ZnCl_2$) [1]. SEM and TEM Fig. 3 show that sample ZnVO_20_100°C has morphology 2D nanosheets. SEM EDX analysis demonstrated uniform elements distribution.

The data of nitrogen ad(de)sorption (Table 1) shows that samples were synthesized by ultrasonic method have higher specific surface area then ZnVO_SS sample.

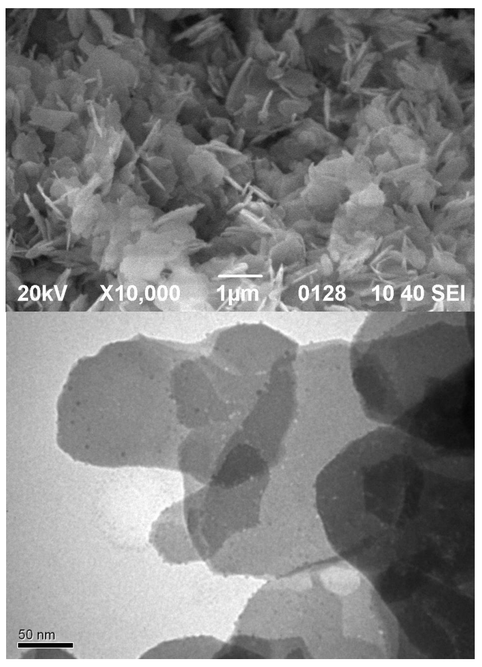


**Fig. 3. SEM (a) and TEM (b) images of ZnVO_20_100°C**

**Table. 1. $S_{BET}$ initial oxides and zinc vanadate**

| № | Sample | $S_{BET}$, $m^2/g$ |
|---|---|---|
| 1 | ZnO_initial | 5 |
| 2 | $V_2O_5$_initial | 2 |
| 3 | ZnVO_SS | 1 |
| 4 | ZnVO_20_100°C | 9 |
| 5 | ZnVO_20_500°C | 14 |
| 6 | ZnVO_80_100°C | 15 |

**Conclusions.** Thus, in contrast to conventional co-precipitation syntheses (which needed a lot of water for washing) or solid-state syntheses (which requires high temperatures) the ultrasonic method of synthesis lets obtained nanostructured **$Zn_3V_2O_8$** with high $S_{BET}$. The ultrasonic treatment of oxides ZnO and $V_2O_5$ as raw materials for synthesis **$Zn_3V_2O_8$** is a cheap and eco friendly method of synthesis.

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