ZnO nanopowders: synthesis approaches and properties

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INTRODUCTION

Zinc oxide nanopowders are an important metal oxide with unusual semiconducting properties and wide application in various fields, such as catalysis, optic, pigment, piezoelectric devices, chemical sensors, cosmetic ingredients, medicine. Due to the large numerous of toxic chemicals and extreme environment employed in the chemical production of ZnO nanopowders, chemistry methods employing the use of different biological materials (plants, fungus, bacteria, algae) and natural polymers (agar, gelatin, starch, different proteins) have been adopted. Besides that, the use of natural sources in the synthesis of nanomaterials can have a low cost and eco-friendly approach.

MATERIALS AND METHODS

ZnO nanopowders were synthesized by sol-gel technique with agar as a complexing agent. Deionized water was used as solvent. The zinc nitrate solution was added to the agar solution, and the container was moved to a water bath. The temperature of the water bath was fixed at 80 °C. Stirring was continued for 12 h to obtain a brown gel. The final product was calcined at 500, 600 and 700 °C in air for 8 h

RESULTS AND DISCUSSION

The thermogravimetric curve of the ZnO nanopowder synthesized by the sol– gel method in a agar environment are presented in Fig.1. The TG curve descends until it becomes horizontal around 500 °C. No weight loss between 500 and 600 °C was detected on the TG curve, which indicates the formation of nanocrystalline ZnO as the decomposition product. Oriented attachment mechanism to our opinion becomes main mechanism for such synthesis conditions in the temperature range 500 – 700 °C and is accompanied by notable particle growth (Fig. 2). All the diffraction peaks can be assigned to hexagonal phase with Wurtzite structure with space group (P63mc). Crystallite sizes and lattice strain were studied by using Williamson-Hall method. The estimated crystallite size in synthesized samples ranged from 22 to 100 nm (Fig. 3). The luminescence properties of obtained nanoparticles were investigated.

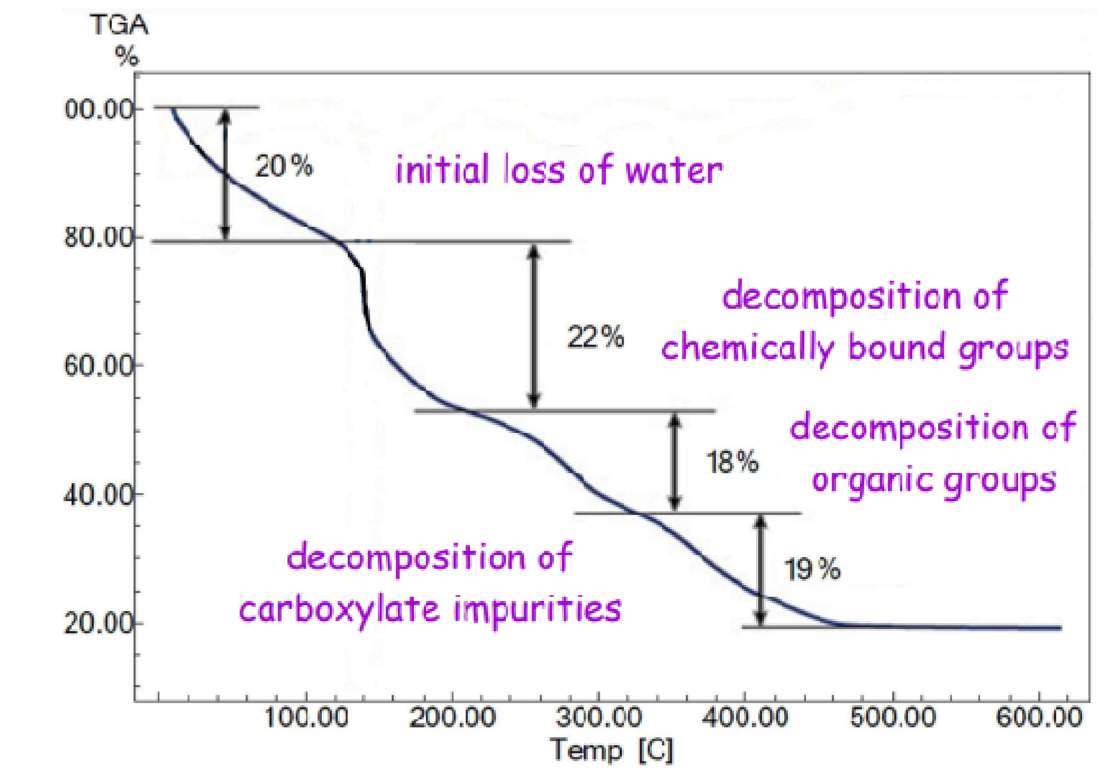

Fig.1. The thermogravimetric curve of the gel.

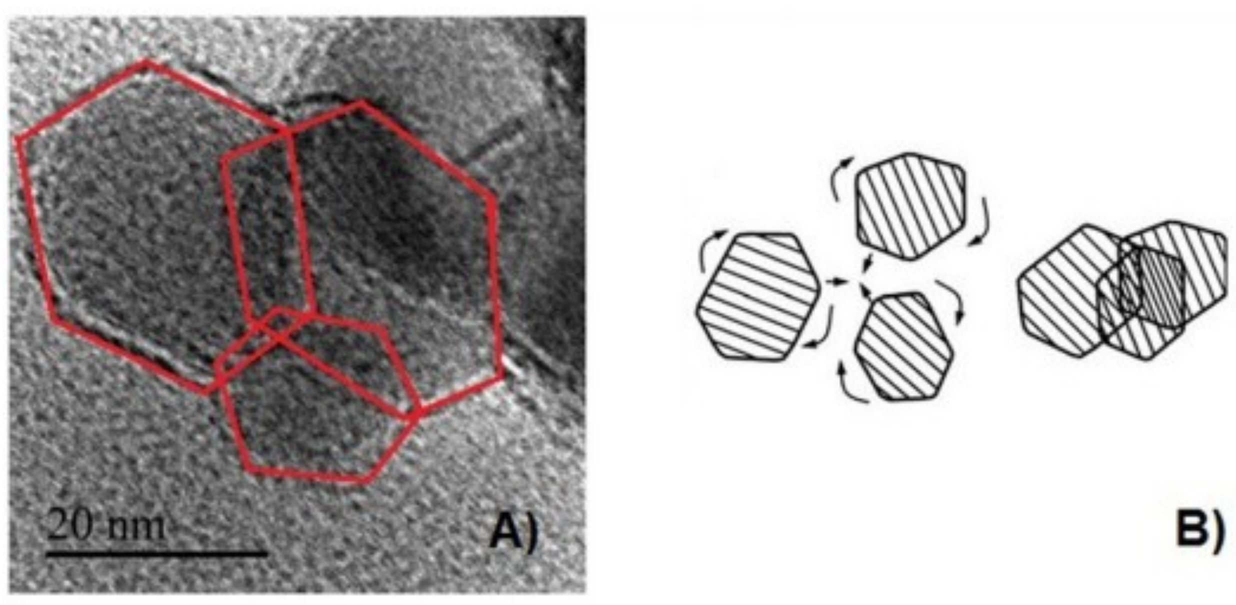

Fig.2. Oriented consolidation (attachment) of ZnO nanoparticles: (A) HRTEM image, calcinations temperature 500 °C, (B) scheme of mechanism.

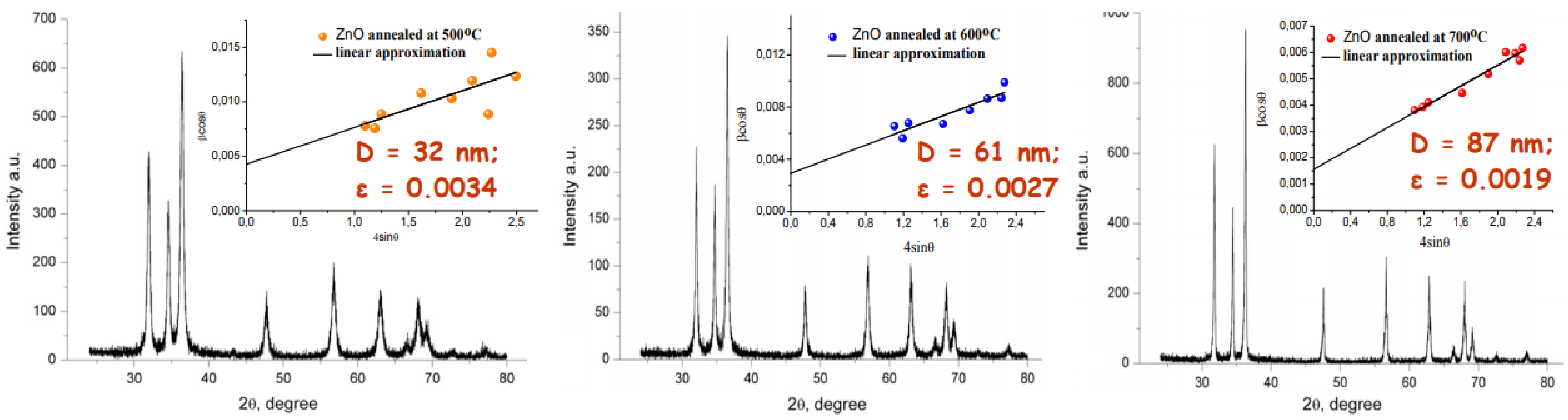

Fig.3. XRD pattern and Williamson-Hall analysis of ZnO nanopowders prepared in agar media prepared

CONCLUSION

- According to X-ray and thermal analysis, single-phase zinc oxide is formed already at 500 °C.
- The microstrain (ε) is decrease and the average crystallite size (D) is increase with an increasing the heating temperature from 500 °C to 700 °C.
- The particles size and the crystals structure defects, which leads to the appearance of lattice stresses are influence to the X-Ray peak broadening.