Facile Method for Synthesizing ZnO Nanorods with Controllable Size

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Introduction

ZnO nanorods have been successfully synthesized by microwave assisted irradiation process using a customized domestic microwave. A simple one step microwave treated method has been used to optimize the synthesis time and the effects of different process parameters such as precursor reagents, synthesis time, precursor concentration, etc. have been studied. The morphological, structural and optical properties of the ZnO nanorods are studied using scanning electron microscope, powder X-ray diffraction and UV-Visible spectroscopy. The results show that all the above-mentioned process parameters influence to some extent the shape, size and properties of the nanorods. The diameter of the nanorods fall in the range of about 300 nm–500 nm and the length in the range of 1.5 μm–4 μm. Nanorods with smaller diameter has been synthesized using Zinc Nitrate precursor. Average diameter of the nanorods increases with precursor concentration and synthesis time. An optimum condition for the customized system with basic precursor solution has been proposed.

Novelty of the present study:

- ✓ The highest possible energy density position has been identified within the domestic microwave oven.
- ✓ ZnO nanorods with high aspect ratio has been synthesized using single step method using the basic precursors.

Objectives:

Development of a facile single-step and cheap method to synthesis ZnO nanorods with high aspect ratio.

Experimental

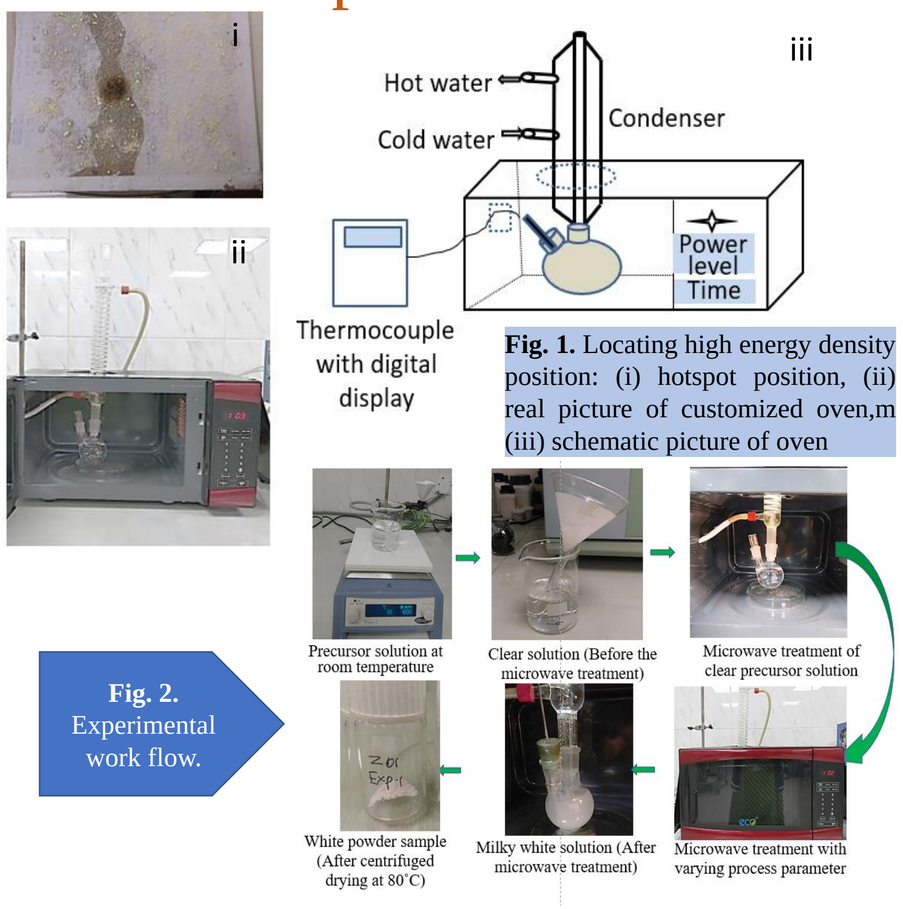


Fig. 1. Locating high energy density position: (i) hotspot position, (ii) real picture of customized oven,m (iii) schematic picture of oven

Fig. 2. Experimental work flow.

Results and Discussion

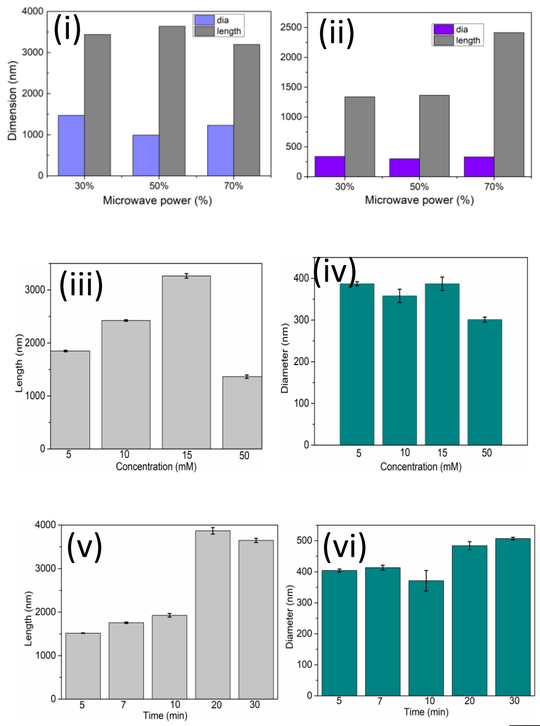
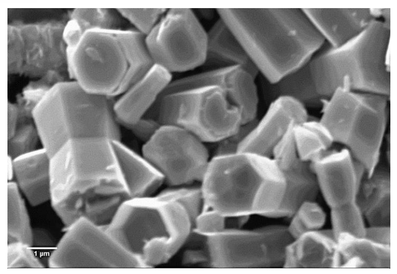


Fig. 3. The average length and diameter of ZnO nanorods
(i) using ZAH, effect of different microwave power.
(ii) Using ZNH, effect of different microwave power.
(iii) &(iv)Effect of precursor concentration.
(v) & (vi) Effect of synthesis time variation.

Fig. 4. Twinned hexagonal prismatic shape of the synthesized ZnO nanorods using ZAH with 50% microwave power and 20 min synthesis time.



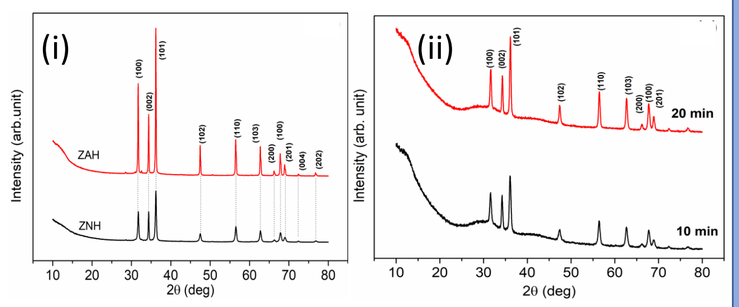


Fig. 5. XRD spectra with of ZnO nanorods with different (i) precursor salt (ii) synthesis time.

Table 1: Atomic percentage obtained from the EDX spectra

Prec._MW_Conc._Time	Zn (at %)	O (at %)
ZNH_50%_15mM_5min	62.21	37.79
ZNH_50%_15mM_7min	59.16	40.84
ZNH_50%_15mM_10min	63.98	36.02
ZNH_50%_15mM_15min	67.50	32.50
ZNH_50%_15mM_20min	58.01	41.99
ZNH_50%_15mM_30min	60.27	39.73

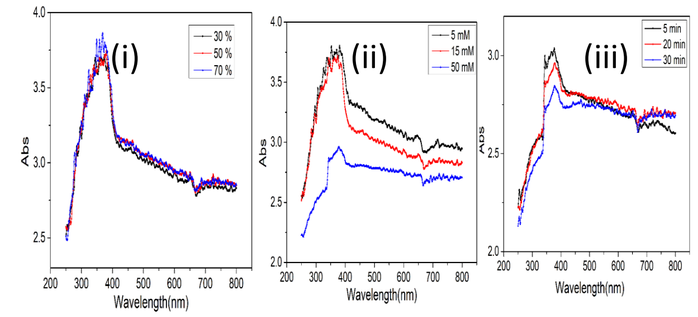


Fig. 6. Effect of (i) microwave power, (ii) concentration, (iii) synthesis time on UV-Vis spectra

Conclusions

Hexagonal wurtzite structured ZnO nanorods with appropriate stoichiometric ratio are successfully synthesized with controlled size for different applications. The method is feasible for industrialization because it a very cheap and facile synthesis process to obtain ZnO nanorods within a very short time. Aspect ratio of the synthesized ZnO nanorods can be varied very easily with precursor concentration and synthesis time. All samples have strong absorption in the UV region having band gap around 3.37 eV, thus can be applicable as anti-UV agent in the textile industries and cosmetics sectors.