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RESEARCH ARTICLE

ANALYSIS OF SOLAR MATERIAL FABRICATION AND DATA ACQUISITION SYSTEM

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ABSTRACT

The synthesis process of solar material fabrication can be automated and interfaced with PC to acquire data such as temperature, time, etc. The main objective is to reduce the manual error and monitoring and to improve the synthesis parameters to achieve better fabrication. The simplest, most economical, most energy-efficient method for synthesizing Aluminum doped zinc oxidenanorods is by using the hydrothermal method, which can be used for solar cell material fabrication. The effects of hydrothermal parameters (including heat-treatment temperature, pH of hydrothermal bath solution, and hydrothermal reaction time) on ZnOnano-rod formation were systematically studied. The UV-sensing properties of all samples were correlated with their structure and morphology. The final morphology and crystal structure of ZnOnano-rods were found to affect the UV-sensing properties. In this work, to regulate the parameters such as temperature of process and duration of process, we proposed microcontroller based temperature controller and monitoring with predefined timing can be designed and implemented. Also to confirm the growth mechanism, we have taken SEM and TEM images to ensure the growth improvement by comparing manual method with automated method

INTRODUCTION

A temperature control system is a programmable thermostat that can keep the home or office at a desired temperature regardless of fluctuating exterior conditions. The advantage of having a temperature control system over a common thermostat is that it can save energy and money by automatically maintaining different temperatures at different times of the day and night. This paper temperature control system consists of a small Microcontroller based controller card with switches which communicate to PC through serial port. After setting the temperature control system to a desired temperature, known as a set point, the system will utilize the heater as needed to maintain that setting for the duration programmed. It can be operated by both PC based simulation software or Microcontroller independently.

ZnO nanostructures can be grown either from solution or from gaseous phase. The gas phase synthesis methods are expensive and complicated. The interests in The ZnOnanorods were prepared from zinc nitrate in synthesis of well-aligned ZnO nanowires or nanorods on a neutral aqueous solution under hydrothermal conditions. Currently transparent conducting oxide (TCO) films have been widely used for applications in solar cells, electro-optical devices and flat panel displays due to their low resistivity and high transmittance in the visible region. Among the conventional TCO films, tin-doped indium oxide (ITO) is usually used. However, due to the toxicity, high cost, and the rareness of the indium in the ITO film, the aluminum doped zinc oxide (AZO) films have recently attracted a great deal of attention because of their properties of non-toxicity, lower material cost, high visible transparency, and high electrical conductivity[1].

The solution phase synthesis is usually done with water. The properties of zinc oxide strongly depend on the synthesis method and the conditions present during processing. The defects during synthesis of the ZnO nanoparticles can be engineered by a slow growth process like hydrothermal method to tune the optical and electronic properties. It is therefore critically important to develop material preparation techniques which control both size and shape while at the same time yield materials with well-defined composition and structural morphologies. The hydrothermal process of growing Al doped ZnO nanostructures for solar cell material has gained immense

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popularity due to its simplicity, and tolerable growth conditions. The methods used for the synthesizing different zinc oxide nanostructures can be broadly classified as follows:

1. Solution phase synthesis: In the solution phase synthesis, the growth process is carried out in a liquid. Some of the solution phase synthesis processes are: zinc acetate hydrate (ZAH) derived nano-colloidal sol-gel route [2], template assisted growth [3,4], spray pyrolysis for growth of thin films [5], hydrothermal [6] and electrophoresis.
2. Gas phase synthesis: Gas phase synthesis uses gaseous environment in closed chambers. Normally the synthesis is carried out at high temperatures ranging from 500°C to 1500°C. Some of the commonly used gas phase methods are: vapour phase transport, which includes vapour solid (VS) and vapour liquid solid (VLS) growth, physical vapour deposition ,chemical vapour deposition ,metal organic chemical vapour deposition (MOCVD), thermal oxidation of pure Zn and condensation and microwave assisted thermal decomposition . Amongst the different methods used for the synthesis of Al doped ZnO nanostructures, the hydrothermal method is attractive because of its simplicity and environment friendly growth conditions.

Existing System

The preparation of solar materials requires sophisticated instrument by controlling the parameters temperature, pH and duration to achieve good synthesis for better result because the properties of material can vary due to the variation of this parameters, since most of the synthesis process is done by manual control the error rate is more and causes deviation in the result. The synthesis of this material can be further characterized such as structural, optical and electrical studies. Most of the characterization related with temperature and PH variation so this has to be automated to improve the synthesis process.

Proposed system

To overcome the drawbacks in manual process the automation of solar material synthesis process can be carried out by monitoring and controlling the parameter temperature. The automation process includes the temperature monitoring and control for the predefined value along with the duration that is given by the user that is PIC microcontroller. The data can be acquired through controller interfaced by PC using RS232. The user interface includes temperature values in degree and time in hr/min/sec format can be given through PC.

A temperature control system consists of a small digital device, wired to a heating and cooling system. About the size of a traditional wall-mounted thermostat, a temperature control system contains a circuit board and memory chip. After setting the temperature control system to a desired temperature, known as a set point, the system will utilize the heater or air conditioning as needed to maintain that setting for the duration programmed. By using a temperature control system you never have to worry about wasting money by forgetting to turn the air conditioning or heater off. Programming the device only takes a few minutes, and weekends can have separate set points to accommodate alternate schedules. It's also easy to override the set point with the touch of a button, in case you want to temporarily be warmer or cooler shown in fig 1.

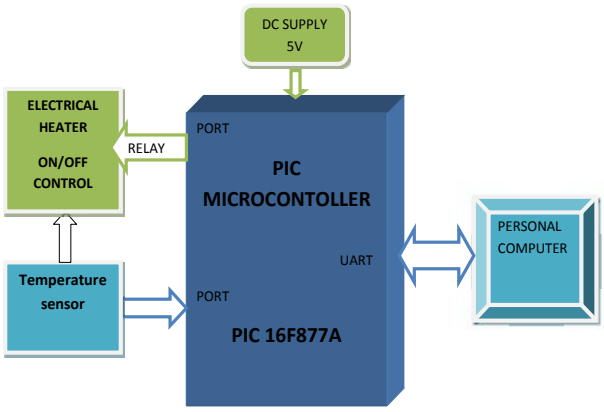


Figure 1 Block diagram of the proposed system

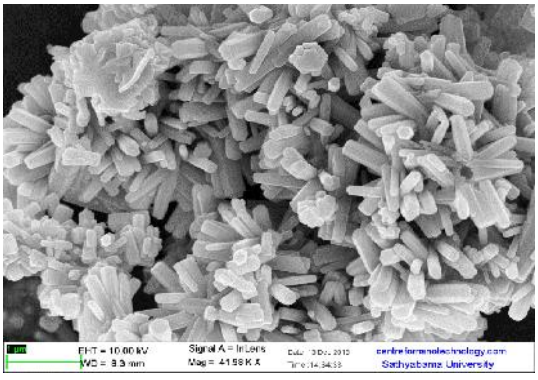
RESULT AND DISCUSSION

Scanning Electron Microscope (SEM) images

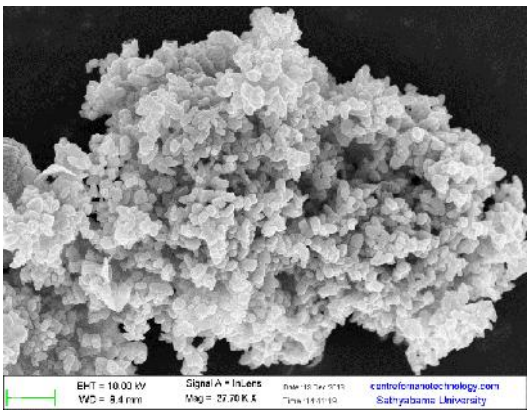
The structural information is the key to understand the nature of the material and it facilitates in correlating the different physical properties.

Scanning Electron Microscope (SEM) Analysis

The scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate a variety of signals at the surface of solid specimens. The signals that derive from electron-sample interactions reveal information about the sample including external morphology, chemical composition, crystalline structure and orientation of materials making up the sample. In most applications, data are collected over a selected area of the surface of the sample, and a 2-dimensional image is generated that displays spatial variations in these properties. In the present study, the figure 2 shows the SEM images of manual hydrothermal process and the microcontroller based automatic control of temperature and duration for controlled synthesis on the morphological of Al doped ZnO nanostructures has been examined.



(a)



(b)

Figure 2 – Growth of Al doped material with a) Manual control and b) Automatic control synthesis process

Scanning electron microscope images of the Al doped ZnO nanostructures synthesized at the pH values of 7 is shown in figure 3. Hexagonal nanorods with radiating patterns of approximately 0.2 - 1 µm in length and 200 nm – 1 µm in diameter are obtained.

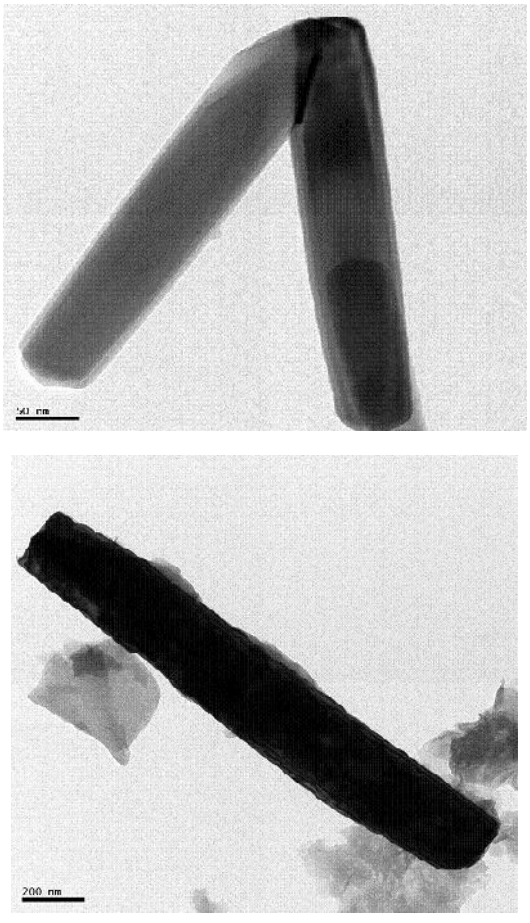


Figure 3 TEM images of prepared sample with a) Manual control and b) Automatic control of synthesis process using microcontroller of solar cell material

This reveals that the synthesis process of fabrication using automatic control has better result on growth of nano-material for solar cell fabrication. TEM confirms the growth size is reduced in automated system.

CONCLUSION AND FUTURE WORK

Solar material fabrication and Data Acquisition System has been designed a proposed model for automatic temperature control which can help for various industrial and laboratory process, where it needs to maintain an constant temperature for different environment conditions. The parameters have been found from the analysis of different parameters for synthesis process by referring the reprints of the nano material process for solar cell material fabrication as hydrothermal process, the simple and inexpensive. Based on the parameters the existing system which has a drawback of manual control is replaced by our design of microcontroller based automatic system. The design has been done with PIC microcontroller and GUI environment using PC to set parameters and acquire the parameter values using RS232.We can implement this model to simple laboratory application to fabricate the solar cell material using nanotechnology. The performance of the system is confirmed by analyzing the growth of material and its structural properties by taking SEM and TEM images.It is clearly indicate that the automation of this system improved the growth with the system designed with fuzzy-logic conditions.

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