Structural Properties of the Zno Nanorods on PES Substrate by Hydrothermal Method According to Growth Temperature

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***Abstract*:** *We study the characterization of ZnO nanorods according to temperature. However, the the amorphous crystal structure as well as the surface morphology of polyestersulfone (PES) substrate is not good. Therefore, we introduced a ZnO buffer layer to facilitate ZnO nanorods growth. Furthermore, in order to control characteristic on the growth of ZnO nanorods, we grew ZnO nanorods on PES in various growth temperature. Additionally, we analyzed the structural characteristics with temperature using XRD, FE-SEM for the fabrication of flexible devices.*

Keywords: *flexible, ZnO, nanorod, hydrothermal method*

1. Introduction

Flexible electronic devices have not only the advantage over existing ones because of flexibility and economic efficiency by ultra-lighten but also applied possibility of many ways. Therefore, Flexible electronic devices will large influence coming electronic industry. Flexible electronic devices should be made under comparatively low temperature condition because of plastic's low melting point. So it is difficult to obtain good properties.

Recently ZnO, possible to process in low temperature condition and have fast electron mobility, is received attention for material used in the flexible electronic devices. ZnO, representative II-VI oxide semiconductor, is chemically stable material having high exciton energy and comparatively wide band gap energy. Also, ZnO is taking center stage under the field of TCO, TTFT, solar cell because it has high light transmittance and electric conductivity. And it is being done a study about band gap engineering for increasing bandgap energy to apply photoelectric element in UV field.

Nano technology has received attention with rapidly changing technologies since 1990. Since Nano technology has good availability and wide variety, it is expected to be a foundation of new technology. Especially Nano technology in semiconductor field will be a innovated technology, for example, when we make high density integrated chips by making electronic elements made by nanostructures. But Nano technology has many technical problems to be solved such as precise synthetic technique, construction technique, etc.

Nanostructure is classed as nano thinfilm, one-dimensional nanostructure such as nanowire, nanorod, nanoribbon and etc and zero-dimensional nanostructure such as macromolecule, quantum dot. One-dimensional nanostructure of these is possible to apply directly to electronic-photonic element such as transistors, diodes, sensor, solar cell and etc. Therefore, such studies are proceeding for putting practical use.

Growing method of one-dimensional ZnO nanostructure is possible to approach a way of bottom-up. Methods are proposed variously because nanostructure grows differently depending on shape or size of that. Pre-existing methods such as MBE(molecular beam epitaxy), PECVD(Plasma-enhanced chemical vapor deposition), PLD(pulsed laser deposition) are expensive and complex operation by using very high temperature and pressure system. In contrast, hydrothermal method is one of methods to obtain a solid solution compound having uniform crystalline. That method can be used under low temperature and pressure condition by using comparatively cheap and straightforward equipment.

2. Experimental Details

2.1. The deposition of ZnO buffer layer

In this experiment, we used an RF magnetron sputter system for the deposition of the ZnO buffer layer. Before deposition, the substrate, which was PES, was 1cm×1cm. In addition, the PES substrate was cleaned with an ultra-sonic cleaner using methanol and DI water. The base pressure of the chamber was maintained at 6.0X10-6 Torr. We also supplied the Ar gas at 20 sccm to create plasma. After that, the deposition pressure of the chamber was maintained at 5 mTorr. However, the crystal structure as well as the surface morphology is not good in PES substrate. Fig. 1 is Schematic diagram of RF magnetron sputter system and TABLE 1 is Deposition conditions of ZnO buffer layer.

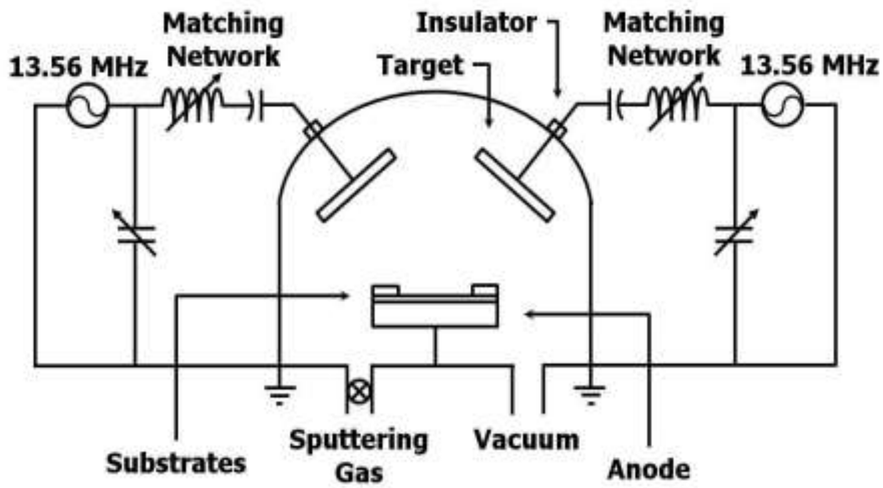


Fig. 1: Schematic diagram of RF magnetron Sputter sytem

TABLE I: Deposition conditions of ZnO buffer layer on PES substrate

Property	Settings
Target	ZnO
Substrate	PES
Power	100 W
Deposition time	20 minute
Thickness	100 nm
Deposition temperature	Room temperature

2.2. Growth of ZnO nanorods

For growth of ZnO nanorods, the solution of ZnO was produced using zinc nitrate hexahydrate, hexamethylenediamine (HMT), and deionized (DI) water. The amount of zinc nitrate hexahydrate and HMT is fixed at 0.3 M%. And we stirred two solutions at each beaker during 15 minutes. After that, we put the flat bottom flask in large beaker, and warm up in a double boiler system using Si oil on the hot plate. And the PES substrate substrate was placed upside down in the flask, because we choose the growth methods of bottom to up. The growth conditions of ZnO are shown Table 2 and Fig. 2 is Schematic diagram of hydrothermal method.

TABLE II: Growth conditions of ZnO nanorods

Property	Settings
Target	ZnO
Substrate	PES
Power	100 W
Deposition time	20 minute
Thickness	100 nm
Deposition temperature	Room temperature

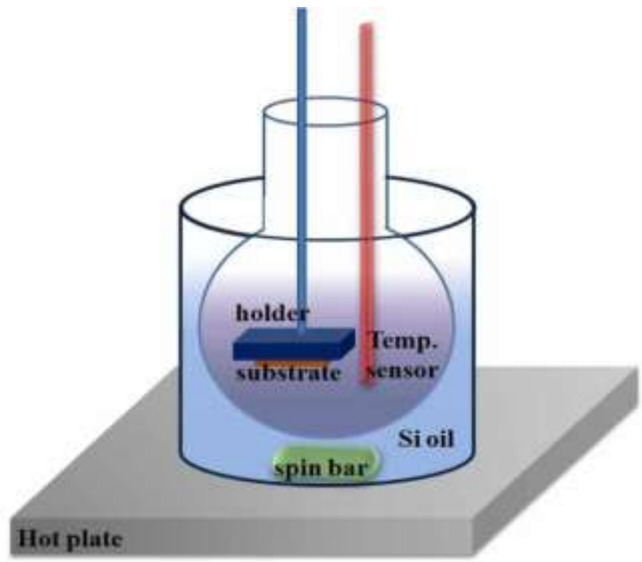


Fig. 2: Schematic diagram of hydrothermal method.

3. Results And Discussion

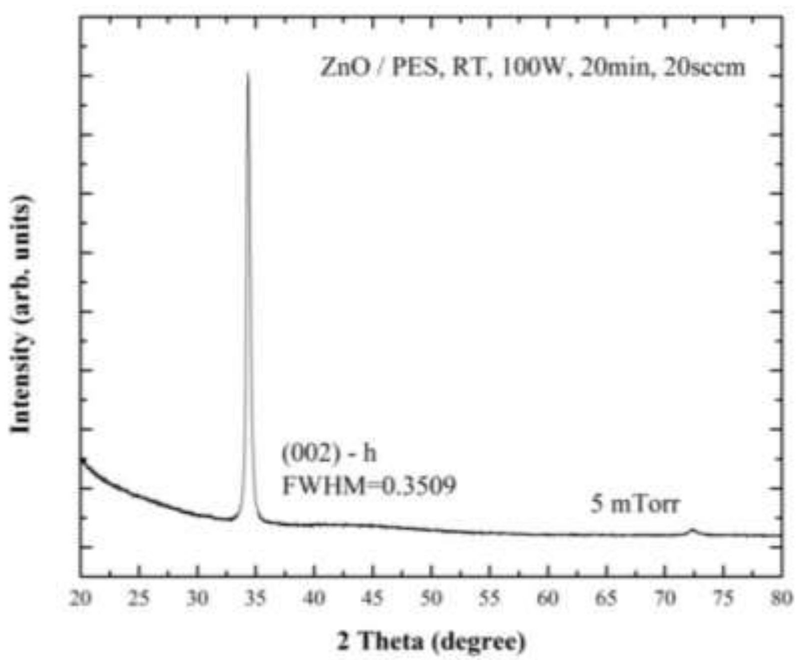
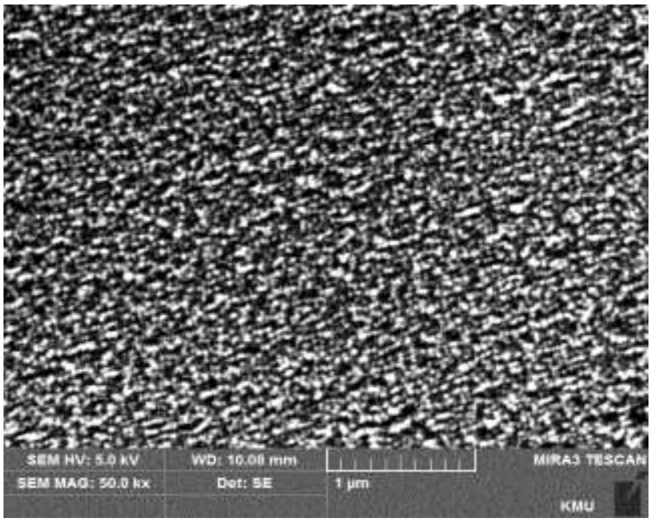
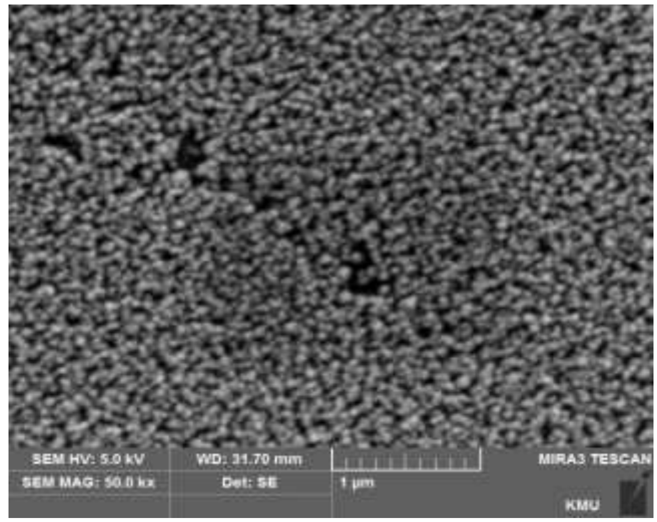


Fig. 3: The result of XRD about ZnO buffer layer.

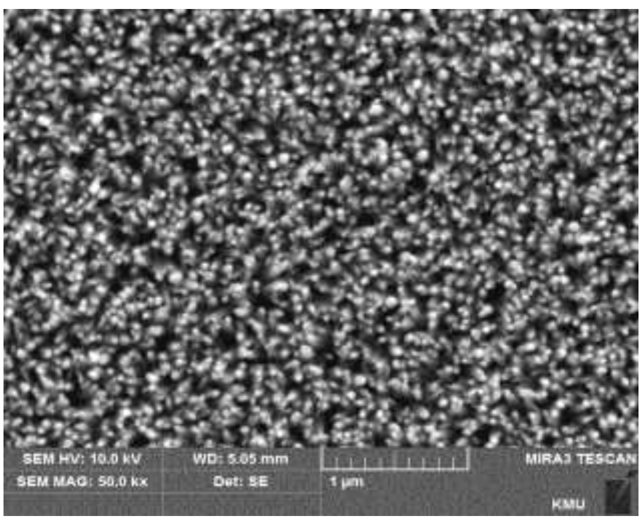
The PES substrate has amorphous structure. So for getting the uniformly ZnO nanorods, it needs to buffer layer. We grow the ZnO buffer layer on the PES substrate by the RF magnetron sputter system. First, we analyzed the ZnO buffer layer. The structural properties of ZnO buffer layer are analyzed by XRD. The result of XRD is shown in Fig 3. The peak of ZnO buffer layer is located nearby 34.5^{o}, the intensity of ZnO buffer layer is so high value, and the FWHM(Full Width at Half Maximum) is 0.3509. So, the structural properties of ZnO buffer layer had great structural properties at this deposition condition. So, ZnO nanorods was grown using this ZnO buffer layer on PES substrate.



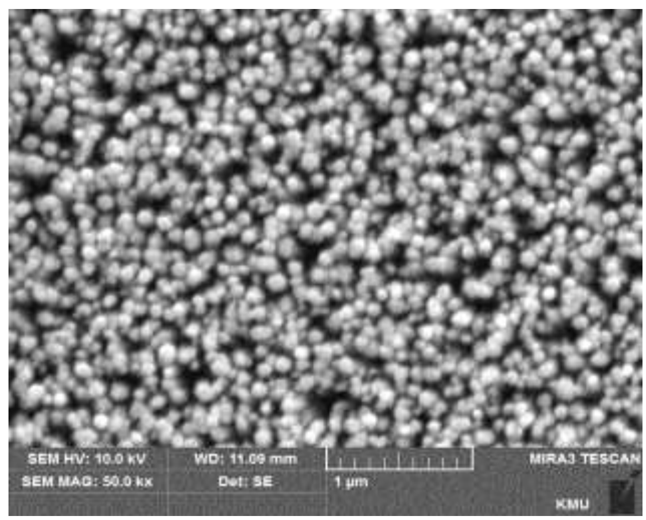
(a)



(b)



(c)



(d)

Fig. 4: The result of FE-SEM about ZnO nanorods according to temperature
(a) 90℃, (b) 110℃, (c) 130℃, and (d) 150℃The result of XRD about ZnO buffer layer.

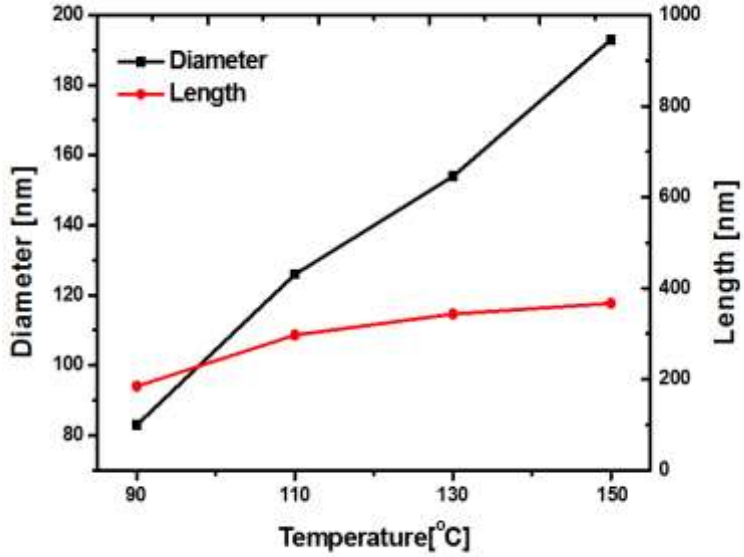


Fig. 5: The length and diameter of ZnO nanorods according to temperature

Fig. 4 is a SEM image for observing the image of the fine ZnO nanorods according to the temperature of growth, the size of each nanorods are shown at graph in Fig. 5. And the density of ZnO nanorods is higher at temperature of 90℃ than temperature of 150℃. The diameter of the ZnO nanorods grown with increasing the density increases linearly until 150℃ of the maximum temperature and, the change of length had a relatively uniform size, regardless of the temperature of about 180 nm. Thus, ZnO nanorods are grown First of the vertical direction, after those particles of ZnO was supplied to the growth in the radial direction. So Growth in the supersaturated solution shows the active shape in the radial direction. And the structural properties of ZnO nanorods can be seen that substantially vertically grown.

4. References

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