

Materials science communication

ZnO nanorods/polyaniline heterojunctions for low-power flexible light sensors



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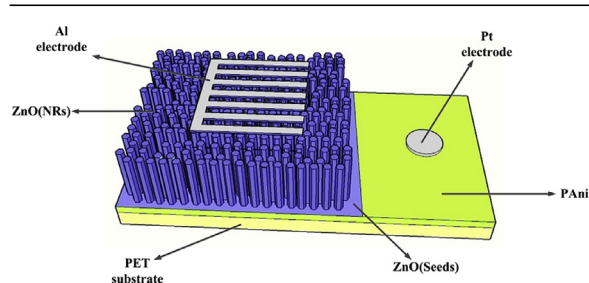
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HIGHLIGHTS

- ZnO NRs/polyaniline p-n junction photodetectors were fabricated on flexible substrates.
- The fabricated ZnO NRs grew along the (002) direction.
- The fabricated ZnO NRs have low compressive strain.
- The ZnO NRs/PAni junction showed a high sensitivity of 85%.
- The photodetectors showed quantum efficiency as high as 12%.

GRAPHICAL ABSTRACT



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ABSTRACT

Zinc oxide nanorods (ZnO NRs) were directly grown on p-type polyaniline (PAni)/polyethylene terephthalate (PET) using chemical bath deposition method at low temperature. Field emission scanning electron microscopy and X-ray diffraction techniques were used to study the morphology and structure of the fabricated films. The resulted ZnO NRs are hexagonal and grew vertically on the PAni surface in the (002) direction along the *c*-axis. The compressive strain, Raman and photoluminescence measurements confirmed the high-quality crystal structure of the formed ZnO NRs with no damage of the PAni surface. The photodetector made using ZnO NRs/PAni junction showed a sensitivity of 85% and a quantum efficiency of 12.3% at 5 V.

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1. Introduction

Flexible sensors are playing an increasingly paramount role in optoelectronics applications [1]. While the most sizably

voluminous market is currently for glucose sensors utilized by diabetics, other types of flexible sensors are emerging [1]. IDTechEx forecasts that the market for flexible sensors will have incremented by more than \$1 billion by 2020 [2]. To this end, several types of flexible polymeric materials, such as polyethylene terephthalate (PET) and polyethylene naphthalate (PEN), are currently considered due to their exceptional dielectric properties, corrosion resistance, high processing temperature between 196 and 260 °C, low coefficient of friction, and low cost among other credentials. In particular,

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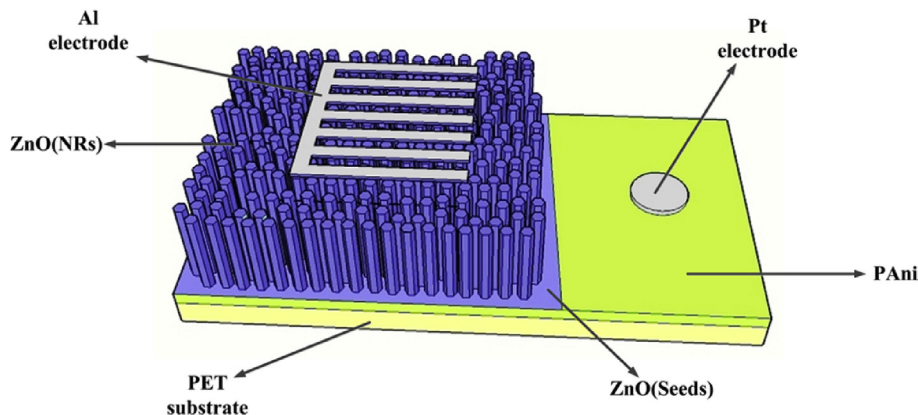


Fig. 1. Schematic illustration of the UV photodetector based on n- ZnO(NRs)/p-PAni on PET substrate.

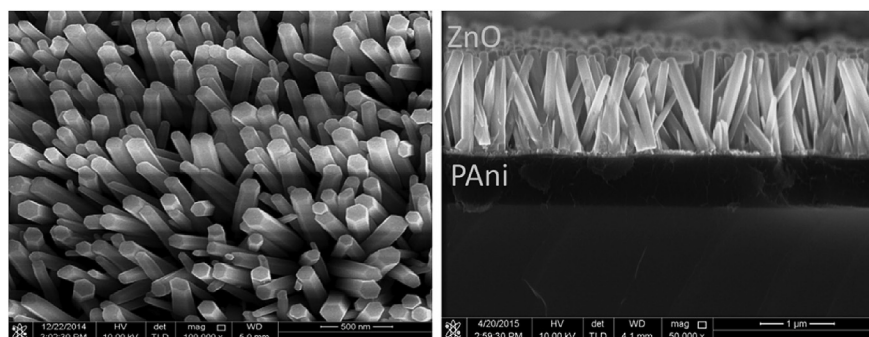


Fig. 2. FESEM images of ZnO nanorods/PAni formed at 90 °C for 3 h.

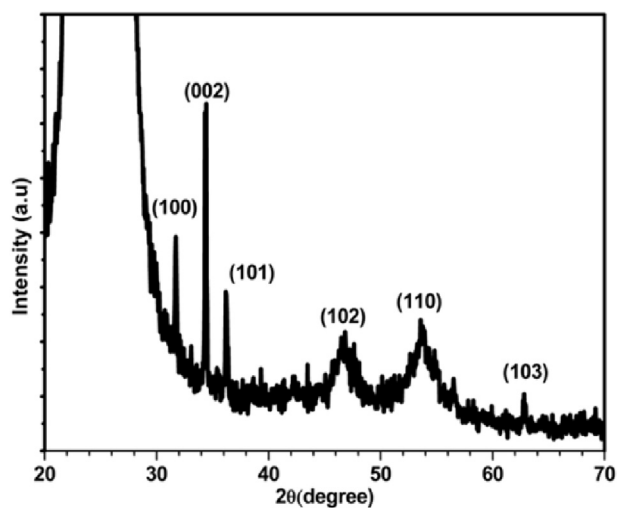


Fig. 3. XRD spectra for the fabricated ZnO NRs/PAni heterojunctions.

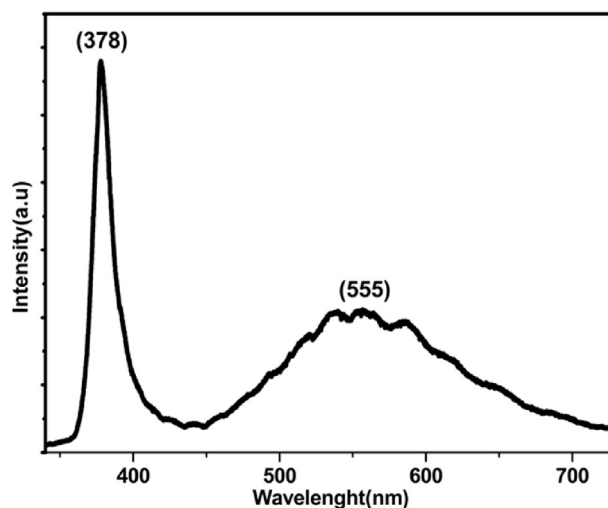


Fig. 4. Photoluminescence spectrum of ZnO NRs/PAni on PET substrate.

PET is more advantageous over indium-doped tin oxide (ITO) and fluorine-doped tin oxide (FTO) due to its high transparency, good flexibility, availability on industrial scale, and low cost [3].

On the other hand, ZnO nanorods have recently attracted consequential attention due to their unique shape and structure resulting in remarkable piezoelectric, magnetic, and optoelectronic properties. Specifically, the high optical gain of ZnO [4] makes it the material of focus in optoelectronics and sensing applications. However, the difficulty of doping ZnO to p-type polarity has led the

researchers to seek to create heterojunctions with other p-type semiconductors to enable the use of ZnO in a plethora of electronic devices [1]. In particular, the combination of ZnO with polymers is a current hot research focus [1]. In this regard, most of ZnO NRs/polymer-based heterostructures are synthesized through surface coating of the polymer layer, with very limited reports on the direct growth of ZnO NRs on conducting polymeric substrates. To this end, aqueous chemical growth method has been greatly employed to assemble ZnO nanorods on a variety of substrates including

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