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Crossed zinc oxide nanorods for ultraviolet radiation detection

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ABSTRACT

An ultraviolet photosensor has been successfully constructed by the in situ lift-out method in a focused ion beam system. The prototype consists of individual naturally self-assembled crossed ZnO nanorods grown by an aqueous solution process. The current–voltage (I–V) characteristics show linear behavior. The photosensor exhibits a response of ~15 mA/W for UV light (361 nm) under 1 V bias. Response measurements showed that such a photosensor is suitable for low levels of ultraviolet detection. The method is simple, rapid and applicable to research prototypes for further studies of crossed ZnO nanorods for nano-device applications.

1. Introduction

Ultraviolet (UV) photosensors are devices that have a range of applications in medicine, ecology, commercial, space communications, high-temperature plasma research, chemical and biological sensing, and in military as flame and missile launching detection, etc. [1–4]. UV detectors are used to monitor and determine the Earth's ozone layer thickness. This wide area of UV sensor applications implies multiple requirements that cannot be satisfied by a single device. Solid-state UV photodetectors are more efficient and lightweight [3,4] and can be easily incorporated in different novel types of micro/nanosystems and MEMS/NEMS. These portable devices can help people to monitor their exposure to solar UV radiation, etc.

In the last few years there was an increased interest in solid-state UV sensors based on the fact that miniature detectors for the UV range in comparison with other spectral ranges are so far not commonly used. Although now several kinds of photosensors are provided for the UV range, the development of nanosensors for these applications will enable more portable detectors.

Usually, direct wide-band-gap materials like GaN [5], ZnSe [6], and AlGaN [7] are used as sensing material. Analog to III–V materials, ZnO also possesses high UV photosensitivity which is most important for ultraviolet photodetection. Thus, zinc oxide is also a potentially strong UV sensing material [8–11].

ZnO attracted great interest for such applications due to its large binding energy of 60 meV, wide band gap of 3.37 eV at 300 K, its capability to operate at a high temperature and in harsh environment [2]. In addition, ZnO exhibits the most abundant configurations of nanostructures.

Recently, one-dimensional zinc oxide nanorods, nanowires demonstrated potential applications as next-generation of UV sensors [9–11]. However, its photocarriers life-time is long and it has lower photosensitivity [8].

To date, only a few papers report on single zinc oxide nanorods, nanowires [8,11–13], but none addresses the UV sensitivity of self-assembled crossed ZnO nanorods grown by aqueous solution.

Recently, the physical properties of nano-structured ZnO materials, such as nanorods [12], nano-tripods [13], nano-ribbon [14]

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