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Fabrication and characterization of an individual ZnO microwire-based UV photodetector

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ABSTRACT

In this paper, a single ZnO microwire-based photodetector for the monitoring of ultraviolet (UV) radiation is described. Single crystal ZnO microwires were synthesized using a chemical vapor deposition (CVD) on the Si or Al_2O_3 substrate. The UV photodetector was fabricated by using in-situ lift-out method in a focused ion beam system to manipulate individual zinc oxide microwire. The photodetector prototype consists of a single ZnO microwire (20 μm in length) and exhibits a response of ~10 mA/W for UV light (365 nm) under 1 V bias. The transient response measurements revealed relatively fast response. The effect of oxygen adsorption and of different relative humidity conditions on the electronic transport through individual microwire is explored and discussed.

1. Introduction

In the past decade, ultraviolet rays reaching the earth's surface have intensified due to increasing stratospheric ozone depletion, and they may cause adverse effects on the human body, like high skin cancer rates, etc. In this connection there is a strong motivation for the development of small, low-cost, robust, and efficient ultraviolet (UV) detectors able to work in diverse conditions and that can be installed in different customer electronic devices easily. Besides this, UV photodetectors found wide applications in flame sensing, missile plume detection, chemical/biological analysis and advanced optical communications. For further developments a number of requirements and constrains like radiation hardness, reliability, light weight, minimal power consuming and order-of-magnitude performance advances in detectors and enabling technologies must be met.

II–VI semiconducting oxide materials have been regarded as promising materials due to their potential application in ultraviolet radiation detectors [1–10]. In this context, zinc oxide has been reported extensively for different UV detection applications [1–4], due to its radiation resilient properties [5,6], wide band gap of 3.36 eV that makes ZnO a strong candidate for high temperature electronic devices with reliable operation in space and other harsh environments. ZnO can emit laser light in the ultraviolet range up to room temperature, thus it can be used in highly-efficient miniaturized light sources (e.g. optical storage, microanalysis and in combination with a phosphor as bright white-light-source displays). Based on multiple advantages of ZnO for device applications in comparison with other wide band gap semiconductor materials, such as GaN, SiC, diamond, it is suitable for fabrication of long lifetime devices. Recent reports demonstrate fabrication of UV photodetectors using ZnO nano/microrods and wires [1–4].

To this date, ZnO materials have been grown by a variety of methods such as pulsed laser deposition, vapor phase transport process, chemical vapor deposition method, hydrothermal and aqueous solution deposition [1–12]. However, the nano-size makes

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