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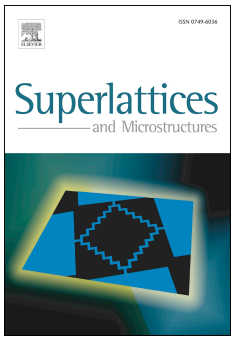

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Performance Analyses of Schottky Diodes with Au/ Pd Contacts on n-ZnO thin films as UV detectors

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***Abstract*—In this paper, we report fabrication and performance analyses of UV detectors based on ZnO thin film Schottky diodes with Au and Pd contacts. RF magnetron sputtering technique has been used to deposit the nano-crystalline ZnO thin film, at room temperature. Characterization techniques such as XRD, AFM and SEM provided valuable information related to the micro-structural & optical properties of the thin film. The results show that the prepared thin film has good crystalline orientation and minimal surface roughness, with an optical bandgap of 3.1 eV. I-V and C-V characteristics were evaluated that indicate non-linear behaviour of the diodes with rectification ratios (IF/IR) of 19 and 427, at ± 4V, for Au/ZnO and Pd/ZnO Schottky diodes, respectively. The fabricated Schottky diodes when exposed to a UV light of 365 nm wavelength, at an applied bias of -2 V, exhibited responsivity of 10.16 and 22.7 A/W, for Au and Pd Schottky contacts, respectively. The Pd based Schottky photo-detectors were found to exhibit better performance with superior values of detectivity and photoconductive gain of 1.95 x 10^{10} cm.$Hz^{0.5}$/ W & 77.18, over those obtained for the Au based detectors which were observed to be 1.23 x 10^{10} cm. $Hz^{0.5}$/W & 34.5, respectively.**

***Index Terms*—ZnO Thin films, Gold, Palladium, Schottky Diodes, RF magnetron sputtering, Electrical Properties, UV detector**

I. INTRODUCTION

SOLAR UV radiation affects human beings adversely in variety of ways, causing cataract, lesions, photoaging, skin cancer and damage to the DNA structure. Various other artificial UV sources in medicine and industry also pose the same hazard. Although the atmosphere absorbs a significant portion of the solar UV radiation, the depletion of the stratospheric ozone is exposing humans to its harmful spectra with an higher intensity. It underscores the need to design and develop efficient and highly sensitive photo sensors at lower costs. Nano-crystalline Zinc Oxide (ZnO) thin films, with a wide band gap (3.37 eV), large exciton binding energy (60 meV) and high surface to volume ratio, are being developed as an alternative to the existing Gallium Nitride (GaN) based sensors that have low responsivity at a high cost. ZnO is also a suitable semiconductor material for wide range of electronic device applications such as, laser diodes, thin film transistors (TFT), gas sensors, solar cells, piezo-electronic nano-generators, SAW resonators, and micro-electro mechanical devices [1–7], due to its excellent semiconductor and piezo-electrical properties. Realization of homogeneous thin film based opto-electronic devices requires doping of both kinds, although it is quite difficult to obtain a stable and reliable p-type ZnO semiconductor material [8]. Alternative techniques make use of metal-semiconductor Schottky contacts to obtain the fundamental devices such as diodes and TFTs, as reported by researchers in the recent past [9–12]. All these studies have explored possibilities of developing high performance ZnO UV photo detectors with high efficiency, low-dark current, high contrast ratio, simple structure and low cost. Fabrication of the ZnO thin films on silicon substrates helps us in achieving an integrated approach with the existing silicon technology. In this study, we demonstrate low power UV photo detectors based on ZnO thin films with gold (Au) and palladium (Pd) Schottky contacts on silicon wafer. The electroptical properties of both these detectors with thermally stable high Schottky barriers have been studied and compared.

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II. EXPERIMENTAL DETAILS

A. Preparation of ZnO thin film

In order to study the electroptical properties of the proposed devices, a nano-crystalline ZnO film was grown on a n-type silicon (Si) (101) substrate using RF magnetron sputtering, at room temperature. The process of cleaning the Si wafer was done in two steps- RCA-1 (10 minutes boiling in $NH_3 + H_2O_2 + 6H_2O$) and RCA-2 (10 minutes in $HCl + H_2O_2 + 6H_2O$ at 60°C), before deposition of the ZnO thin film. The deposition of ZnO thin film (340 nm) was carried out in 30 minutes and the following process parameters were maintained: a base vacuum of 5 x 10^{-6} T , pressure of 7.5 x 10^{-3} T and RF power of 100 Watts. The target to substrate distance was 7.5 cm. The basic structural, surface morphological, and optical properties of ZnO thin film were characterized by X-ray diffractometer (XRD) (Rigaku, Smartlab-3KW), Atomic Force Microscope (AFM) (Bruker, Multimode8-HR), Scanning Electron Micro-scope (SEM) (Nova Nano FE-SEM, 450) and UV-VIS-NIR Spectrometer (Shimadzu MPC3600).

B. Fabrication of Schottky diode

Schematic diagram of the proposed structure is shown in Fig. 1(a). Aluminium layer of thickness of ~100 nm was deposited on the back side of the Si wafer by vacuum coating technique, to act as an ohmic contact. Circular Schottky