UV radiation and CH_4 gas detection with a single ZnO:Pd nanowire

O. Lupan,[a,b,c,d], R. Adelung,[b] V. Postica,[c] N. Ababii,[c] L. Chow,[d] B. Viana,[a] T. Pauporté[a]

[a] PSL Research University, Chimie ParisTech-CNRS, Institut de Recherche de Chimie Paris, 11 rue P. et M. Curie, 75005 Paris, France
[b] Functional Nanomaterials, Institute for Materials Science, Christian Albrechts University of Kiel, 24143 Kiel, Germany
[c] Department of Microelectronics and Biomedical Engineering, Technical University of Moldova, 168 Stefan cel Mare Blvd., MD-2004, Chisinau, Republic of Moldova
[d] Department of Physics, University of Central Florida, Orlando, FL 32816-2385, USA

ABSTRACT

There is an increasing demand for sensors to monitor environmental levels of ultraviolet (UV) radiation and pollutant gases. In this work, an individual nanowire of Pd modified ZnO nanowire (ZnO:Pd NW) was integrated in a nanosensor device for efficient and fast detection of UV light and CH_4 gas at room temperature. Crystalline ZnO:Pd nanowire/nanorod arrays were synthesized onto fluorine doped tin oxide (FTO) substrates by electrochemical deposition (ECD) at relative low-temperatures (90 °C) with different concentrations of $PdCl_2$ in electrolyte solution and investigated by SEM and EDX. Nanodevices were fabricated using dual beam focused electron/ion beam (FIB/SEM) system and showed improved UV radiation response compared to pristine ZnO NW, reported previously by our group. The UV response was increased by one order in magnitude (≈ 11) for ZnO:Pd NW. Gas sensing measurements demonstrated a higher gas response and rapidity to methane (CH_4 gas, 100 ppm) at room temperature, showing promising results for multifunctional applications. Also, due to miniature size and ultra-low power consumption of these sensors, it is possible to integrate them into portable devices easily, such as smartphones, digital clock, flame detection, missile lunching and other smart devices .

Keywords: ZnO, nanosensor, methane, UV light, multifunctional.

1. INTRODUCTION

UV light is known to be beneficial for people at low dose due to production of vitamin D, which is very important for immunoregulatory processes [1-2]. Low vitamin D status is extremely common nowadays and may lead to the development of different diseases, such as rickets, psoriasis, eczema, and *etc.* [1]. Moderate UV radiation exposure can prevent many of these diseases, as demonstrated by clinical investigations [2]. On the other hand, long exposure of ultraviolet B rays (UVB, λ = 280 – 315 nm), may results in different acute and chronic diseases of the skin, including skin cancer [3]. In clinical conditions, the UV exposure takes place under control of medical supervision, thus, prolonged exposure to UV radiation is considerably reduced. For people who are long time exposed to UV radiation from sunlight, the risk of skin diseases is higher. The CH_4 gas monitoring is also very important for the purpose of safety in homes, industries and mines [4]. At a concentration of 5-14% concentration of CH_4 gas in air, methane is highly explosive, it is a frequent cause of disasters in homes and industries [4].

Therefore, it is necessary to develop a multifunctional miniature device able to continuously monitor the time exposure to UV light and concentration of CH_4 in air. In this work, we present a nanosensor device based on an individual ZnO:Pd NW, which can perform simultaneously several tasks at the same operating conditions, i.e. the detection of UV light (λ = 365 nm) and CH_4 gas in small concentrations (100 ppm). Multifunctional operation is possible at room temperature operation due to the nanometric size of sensing material [5], thus the necessity of micro-heater element and thermometer plate is avoided resulting in ultra-low power detection of UV light and CH_4 gas with the same sensing material.

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