Highly sensitive photoresistor based on ZnO nanorods grown by the hydrothermal method

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Zinc oxide is extensively studied II-VI semiconductor with a direct energy gap of about 3.37 eV at room temperature and high transparency in visible light spectral region. Due to these properties, ZnO is an attractive material for applications in photovoltaic, electronic and optoelectronic devices. ZnO nanorods, due to a well-developed surface, have potential of applications in sensor technology.

In this work we present a new inexpensive method of the ultra-fast growth of ZnO nanorods from the aqueous solution. This environment friendly and fully reproducible method allows growth of nanorods in few minutes time on various substrates, without any catalyst or complexing agent. Growth temperature does not exceed 50ºC and growth can be performed at atmospheric pressure. Moreover the method is also very safe, it requires organic, non-toxic and low-price precursors. The growth can be performed on almost any type of substrate through the homo-nucleation as well as hetero-nucleation. Moreover received nanorods are characterized by a very high quality - they are monocrystalline as confirmed by XRD and transmission electron microscopy. Importantly oxygen vacancies are not found in the photoluminescence measurements.

First results for obtained by us ZnO nanorods in sensor applications are very promising. Resistance UV sensor, based on ZnO nanorods grown on a quartz substrates shows high sensitivity of 20 mW/m^2 (2 $\mu W/cm^2$) for point contacts. The obtained ZnO nanorods are also applied in simple-architecture photovoltaic cells (efficiency over 12%) in conjunction with low-price Si substrates.

In this work we present a high-sensitive photoresistor based on junction between Si substrate (low p-type) and ZnO nanorods (n-type). We assume that effect of photocurrent is related to trapping of carriers as a result of band folding. Detailed information about technology and measurements will be presented.

This work was partly supported by the Polish National Science Centre (NCN) grant no. DEC-2012/06/A/ST7/00398.

[1] B. S. Witkowski, et al., *Ultra-fast growth of the monocrystalline zinc oxide nanorods from the aqueous solution*, Int. J. Nanotechnol., Vol. 11, Nos. 9/10/11, 2014
[2] R. Pietruszka, et al., *Photovoltaic properties of ZnO nanorods/p-type Si heterojunction structures*, Beilstein J. Nanotechnol. 2014, 5, 173–179.
[3] B.S. Witkowski, et al., *UV detector based on zinc oxide nanorods obtained by the hydrothermal method*, Phys. Status Solidi C 2014, 1–5 / DOI 10.1002/pssc.201300761