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Ultra-Fast Growth of ZnO Nanorods from Aqueous Solution: Technology and Applications

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Abstract : 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 and photovoltaics. 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. The method is characterized by simplicity and allows regulation of size of the ZnO nanorods in a large extent. 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/m2 (2 μW/cm2) for point contacts, especially that the results are obtained for the nanorods array, not for a single nanorod. UV light (below 400 nm of wavelength) generates electron-hole pairs, which results in a removal from the surfaces of the water vapor and hydroxyl groups. This reduces the depletion layer in nanorods, and thus lowers the resistance of the structure. The so-obtained sensor works at room temperature and does not need the annealing to reset to initial state. Details of the technology and the first sensors results will be presented. The obtained ZnO nanorods are also applied in simple-architecture photovoltaic cells (efficiency over 12%) in conjunction with low-price Si substrates and high-sensitive photoresistors. Details informations about technology and applications will be presented.

Keywords : hydrothermal method, photoresistor, photovoltaic cells, ZnO nanorods
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