Abstract

"Characterization of surface properties of low dimensional zinc oxide ZnO nanostructures for potential microelectronics application"

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The aim of the doctoral thesis was to determine the basic surface properties of selected zinc oxide ZnO nanostructures in terms of their potential application in microelectronics.

The studied objects were low dimensional: two dimensional ZnO nanostructures in the form of nanolayers deposited on a silicon (Si) substrate by Direct Current Magnetron Sputtering (DCMS), and one dimensional ZnO nanostructures in the form of nanowires, fabricated on a silicon (Si) substrate by Physical Vapour Deposition (PVD).

The goal of the experiments was to characterize the surface properties of the above-mentioned ZnO nanostructures in view of their application in microelectronics, especially for the protection of the environment, health and even human life, with nanostructured ZnO thin films verified as an active material in photocatalytic water purification; ZnO nanowires were used as a sensor material in a toxic gas sensor based on the surface photovoltage effect (SPV).

Series of different studies using complementary research methods in a proper order were carried out. Owing to the usage of Atomic Force Microscope (AFM) and Scanning Electron Microscope (SEM), it was possible to obtain the key information on the surface morphology of the objects under study, including the structure of the samples, grain size, and the changes occurring on their surface before and after subsequent application experiments. By means of the X-ray Photoelectron Spectroscopy (XPS) the key information could be obtained about the surface chemical properties of the studied objects, including their surface non-stoichiometry, and the type of chemical bonds, as well as the presence of surface impurities, mainly carbon (C), resulting from the uncontrolled contact of the used selected ZnO nanostructures with impurities present in the atmosphere or water. Moreover, in case of ZnO nanowires, the behaviour of C impurities could be determined, including, in particular, the possibility of their removal by thermal desorption in very high vacuum by using a combination of Thermal Desorption Spectroscopy (TDS) combined with XPS studies.

The purpose of the work was to identify the possible applications of DCMS nanostructured ZnO thin films as photocatalytic material for water purification (using methylene blue) and ZnO nanowires as the sensing material for toxic gas sensors, based on the effect of surface photovoltage (SPV) for the detection of the dangerous toxic gas nitrogen dioxide NO_2.

The information resulting from the doctoral thesis is crucial, as on the one hand the basic surface properties of the selected ZnO nanostructures were obtained, which is of great cognitive importance, and on the other hand, the application opportunities of the objects in microelectronics were confirmed, including the potential application in water treatment for the photocatalytic process (nanostructured ZnO thin films) and for toxic gas detection (ZnO nanowires).