SPECTROSCOPIC STUDY ON THE INFLUENCE OF POST-PROCESSING ANNEALING ON ZNO FILMS PRODUCED WITH A SOL-GEL METHOD

Ewelina Nowak[1], Mirosław Szybowicz[1], Alicja Stachowiak[2], Edyta Chłopocka[1], Daria Piechowiak[3]

[1] Institute of Materials Research and Quantum Engineering, Faculty of Materials Engineering and Technical Physics, Poznań University of Technology, Poland
[2] Institute of Physics, Faculty of Materials Engineering and Technical Physics, Poznań University of Technology, Poland
[3] Institute of Materials Engineering, Faculty of Materials Engineering and Technical Physics, Poznań University of Technology, Poland
ewelina.k.nowak@doctorate.put.poznan.pl

Zinc oxide (ZnO), due to its electrical and optical properties is a promising material for optoelectronic and high power devices. ZnO is a II–VI compound semiconductor with a wide direct bandgap (3.37 eV at room temperature) and large excitation binding energy (around 60 meV). Depending on the specific application, ZnO can be used in the form of powder, nanostructures or single crystals. However, the most popular way to achieve material for electronic purposes is growing of thin layer [1].

In most cases, thin layers of ZnO tend to form zinc blend or wurtzite structure crystallites from an amorphous phase in high temperature [1]. One of the techniques used for ZnO film production is a sol-gel method, which due to ease and low cost of production and deposition, is one of the most popular methods of obtaining functional films for optoelectronics. Unfortunately, besides numerous research focused on the properties of acquired layers [2], the universal method of achieving repeatable samples is still not developed. One of the main problems in production is the appearance of native defects. Undoped ZnO usually contains various intrinsic defects such as Zn vacancies, interstitial Zn, O vacancies, interstitial O, and antisite O. These intrinsic defects form either acceptor level or donor level in the bandgap and greatly affect the optical and electrical properties of ZnO [2].

Moreover, in the growth of ZnO layers, besides native defects, we should take a glance at the behavior of grain growth during the annealing process, which is the basic procedure due to getting rid of organic substances and recrystallization of layers [3]. Understanding the course of the recrystallization process – with special consideration of the influence of the crystal growth kinetics on the substrate's orientation and the presence of defects – seems to be one of the main goals in the development of methods for sol-gel synthesis of thin films on amorphous substrates [3].

The presented research is a comprehensive study on the influence of post-processing annealing on ZnO films produced with a sol-gel method. The main issue was to prepare the sol-gel spin-coated layers in exact same conditions and anneal them in different temperatures and at a different time rate. The purity and chemical composition of samples were investigated with the X-ray photoelectron spectroscopy (XPS). The quality and structure were determined by x-ray diffraction. Complementary measurements, which enabled to estimate the grain sizes and orientation, were conducted with Raman microscopy at room temperature.

Due to the process of the reorientation and growth of crystallites, the defects may be introduced into the material, which leads to fine-tuning the electrons states. That is why for complementary information UV-VIS absorption and photoluminescence measurements were conducted.

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