Controlling the Conductivity of ZnO Films by Oxide Conditions for ZnO Nanorod-Based Devices

Petr Novák[1, a)] and Joe Briscoe [2]

[1] *New Technologies – Research Centre, University of West Bohemia, Plzeň, Czech Republic, e-mail:*
[2] *Materials Research Institute, Queen Mary University of London, Mile End Road, E1 4NS London, UK*

[a)] *Corresponding author: petrnov@ntc.zcu.cz*

Abstract. ZnO nanorod-based devices have been of increasing interest in the field of flexible electronics, catalyst, optoelectronics and energy harvesting. These devices usually contain Zinc oxide film as a seed layer for nanorods and Indium tin oxide (ITO) film as transparent electrode. Since Indium is included in the list of critical raw materials defined by EU commission, research and development activities are required to find new Indium-free solutions. The main aims of the present work are the optimization of the electrical properties of ZnO seed layer and the replacement of the preferably-used ITO by an aluminium doped Zinc oxide (AZO) film.

The use of polymer flexible substrates usually requires the preparation of films at temperatures up to 100 °C. Moreover, low film thickness is needed to avoid failure of the device due to forming of cracks. Thus the achievement of suitable electrical properties of AZO films deposited on flexible thermally-sensitive substrates is still difficult and therefore is subject of intense research.

In this study, all thin-film depositions were performed using a BOC Edwards TF 600 deposition system equipped with two magnetrons linked to a radio-frequency (RF) and direct current (DC) power supply. The use of this deposition system enabled the control of oxygen content in the prepared films. Electrical properties were determined by Hall measurement. The film structure and ZnO nanorods were investigated by the Scanning electron microscopy and X-Ray diffraction. The prepared films were tested on the ZnO nanorod-based piezogenerator.

It was found that the amount of oxygen fundamentally affects the electrical properties of the deposited films. A major reason was identified as the various dominant internal defects depending on the different oxygen conditions during the processing. The control of oxygen amount allows us to achieve lower resistivity of the AZO transparent electrode and also to adjust the seed layer for different types of ZnO nanorod-based devices.