Effect of rapid thermal annealing on properties of ZnO:Ag nanostructures

Vasile POSTICA[1], Oleg LUPAN[1], Rainer ADELUNG[2], Thierry PAUPORTÉ[3]
[1]Department of Microelectronics and Biomedical Engineering, Technical University of Moldova, 168 Stefan cel Mare Blvd., MD-2004 Chisinau, Republic of Moldova
[2]Institute for Materials Science, Kiel University, Kaiser str. 2, D-24143, Kiel, Germany
[3]PSL Research University, Chimie ParisTech-CNRS, Institut de Recherche de Chimie Paris, UMR8247, 11 rue Pierre et Marie Curie, 75005 Paris, France

With fast development of new portable gadgets and other intelligent devices, a wide necessity of multifunctional sensors has appeared [1]. In this context, one dimensional (1-D) nanostructures of metal oxides are excellent candidates as building blocks for nanoscale optoelectronics, nanosensors and electronics [1,2]. Due to small diameter and high surface-to volume ratio of individual nanostructures, the conduction channel is highly dependent on surface reactions [1]. ZnO nanostructures are widely used for fabrication of nanosensors due to easy synthesis and a wide range of morphologies [3]. Further improvements to enhance the sensing properties of ZnO nanostructures can be achieved by doping with transition metals, such as silver (Ag) [1], as well as by thermal annealing in electrical furnace (TA) or by rapid thermal annealing (RTA) [4]. Previous reports clearly demonstrates that Ag-doping of ZnO lead to the diminution of the concentration of donor defects for the compensation of the *n*-type conductivity [1], while thermal annealing (TA) and rapid treatment (RTA) can lead to efficient change in morphology of doped ZnO nanostructured films [4].

Recently, our group has demonstrated efficient Ag-doping and growth of ZnO:Ag NWs by electrochemical method [1,5] and of thin films. Based on individual ZnO:Ag NWs with 150 nm radius the multifunctional sensor devices for fast room temperature hydrogen gas and ultraviolet (UV) light detection were fabricated using FIB/SEM system [1]. The sensors demonstrated the response of ~ 1.6 to 100 ppm of hydrogen gas with relatively fast response and complete recovery of signal [1]. Such response is comparable with those of nanosensors based on pristine ZnO NWs with much lower diameter of ≈ 100 nm, which demonstrate the efficiency of Ag-doping for sensing properties enhancement [1]. In the case of ZnO:Ag nanostructured films synthesized via a simple synthesis from chemical solutions (SCS) approach [4], the RTA and TA treatments at different temperatures and in different inert atmospheres showed efficient change in morphology and defect concentration leading to the improvement of UV and gas sensing properties.

This research was supported by STCU within project 6229.

[1] O. Lupan, V. Cretu, V. Postica, M. Ahmadi, B. R. Cuenya, L. Chow, I. Tiginyanu, B. Viana, Th. Pauporté, R. Adelung, Sens. Actuators B, 223 (2016) 893
[2] X. Duan, Y. Huang, Y. Cui. J. Wang, C.M. Lieber, Nature, 409 (2001) 66
[3] Z.L. Wang, Mater. Today, 7 (2004) 26
[4] V. Postica, I. Hölken, V. Schneider, V. Kaidas, O. Polonskyi, V. Cretu, I. Tiginyanu, F. Faupel, R. Adelung, O. Lupan, Mater. Sci. Semic. Proc.,49 (2016) 20
[5] Th. Pauporté, O. Lupan, J. Zhang, T. Tugsuz, I. Ciofini, F. Labat, B. Viana, ACS Appl. Mater. Interfaces, 7 (2015) 11871