Contribution ID: **44** Type: **Student Communication**

Bi2O3 and ZnO nanowires growth using Vapor–Liquid–Solid (VLS) process for chemical sensors applications

Thursday, 12 September 2019 09:00 (10 minutes)

Previous and current researches in agreement with industrial needs, aim to reduce the dimensions, reduce the price and enhance the sensing performances. Due to their low-cost production, their possibility of miniaturization and their good sensitivity, metal oxides chemical sensors are attracting particular attention. In this study, we report the preparation of ZnO and other new materials such as Bi2O3 nanowires using the vapor liquid solid (VLS) process for chemical sensing applications. In this context, the detection and monitoring of ozone levels are of critical importance. When its level exceeds specific concentrations, the exposure to this gas becomes dangerous to human health, as it causes headache, burning eyes and breathing problems [1]. On the other hand, profiling the body chemistry by monitoring of volatile organic compounds (VOCs) such as Acetone and Ethanol in the breath opens new possibilities in medical diagnostics and in particular diabetes diagnosis. Therefore, fabrication of one-dimensional metal oxides chemical sensors is considered to be an effective approach to these applications. In this study, Vapor- Liquid- Solid (VLS) process is proposed to produce one-dimensional ZnO and Bi2O3 nanowires.
ZnO oxides nanowires were optimized using different catalysts to get the best quality of nanowires for Ozone detection. Morphological, structural, optical and electrical properties of 1D ZnO nanostructures will be studied and discussed. Good quality of ZnO NWs obtained using Cu and Au catalysts with high aspect ratio (Fig. 1). The dynamic response of ZnO nanowires under O3 exposure with different concentrations is reported in Fig. 2. ZnO (Au) NWs show highest and best response (645) while ZnO (Cu) NWs have good response (350) to Ozone.
Bi2O3 have produced using VLS process, characterized and its suitability for chemical application have been proven. High quality of Bi2O3 NWs was produced (Fig. 3). The Au nanoparticles observed on the top of Bi2O3 NWs control the growth and NWs diameters and could enhance the sensing properties. Bi2O3 Sensor was tested under H2, CO, Acetone and Ethanol using different temperatures, and 350 ℃ was found as the best working temperature. good selectivity for Volatile Organic Compounds (VOCs) was observed (Fig. 4). The response of Bi2O3 to low Acetone concentrations opens possibilities for the utilization of Bi2O3 as a new nanomaterial in medical diagnostics in particularly diabetes diagnostic. Moreover, the effect of relative humidity level (from 50 to 90%) was carried out and its impact on gas sensing properties will be discussed.

References
[1] T. R. Koehler, in Dynamical Properties of Solids, edited by G. K. Horton and A. A. Maradudin (North-Holland, Amsterdam, 1975), Vol. 2, p. 3

Summary

Topic

1. Physical and Chemical Sensors

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Session Classification: Morning Session 1