# Synthesis and characterization of mixed oxide nanowires for gas sensing

W. G. C. Kumarage[1], P. S. Jayawardena[2], D. Zappa[1], M. Shimomura[2], N. Poli[1], E. Comini[1]

*[1]SENSOR Laboratory, Department of Information Engineering, University of Brescia, Via Valotti 9, 25133 Brescia, Italy*
*[2] Optical Science Laboratory, Research Institute of Electronics, Shizuoka University, Japan*
*Corresponding authors: elisabetta.comini@unibs.it*
*Presenting author: g.wadumasthree@unibs.it*

A healthy and long-lasting life is the utmost wish of any living being thus aging. The aging phenomenon cannot be stopped but may be controlled to some extent when we live in appropriate environments. Usually, the outdoor environment is polluted by two means natural events (windblown dust, volcano eruptions, etc.) and man-made ones (burning of facile fuels, factories, volatile organic compounds, etc.). Pollution due to harmful air such as sulfur oxides ($SO_2$), nitrogen oxides ($NO_X$), carbon monoxide (CO), ammonia ($NH_3$), methane ($CH_4$), and volatile organic compounds (VOCs) is one of the significant issues since it is more sensitive to compromising the natural ecosystem and environment. So, exposure to these compounds worsens the aging phenomena of the living being (headache, fainting, skin and eye irradiation, respiratory infections, heart disease, lung cancer, and even superficial death). Therefore, it is necessary the detection these compounds in the environment. Accordingly, metal oxides (MOXs) gas sensors have conventionally been employed to detect and quantify harmful gases in both indoor and outdoor environments. However, one of the major problems with these sensors is achieving selective detection. Herein, we propose a novel design with two metal oxides (ZnO and $Co_3O_4$) that provide very high gas response together with superior selectivity.
The proposed structure is a one-dimensional (1D) metal oxide composite; $Co_3O_4$/ZnO nanowires. The composite was prepared by in-situ thermal oxidation of metallic Co thin layer (50 nm) and evaporation of ZnO powder at a temperature of 800 ºC at a pressure of 0.15 mbar. The pressure was maintained by a controlled mixture of $O_2$ and Ar. The morphological, compositional, and structural analyses are evidence of the successful growth of the $Co_3O_4$/ZnO composite nanowire with the root of $Co_3O_4$ and the tip with Pt (catalyzer) and $Co_3O_4$. The gas sensing characterization shows exciting sensing functionality towards acetone ($C_3H_6O$) compared to that of tested gases ($C_2H_5OH$, $H_2S$, $NH_3$, CO, $NO_2$, and $H_2$). The reported highest response (ΔG/G; G is the conductance) was above the value of 5000 toward 50 ppm (parts per million) $C_3H_6O$ at 40 RH% air when working at 250 °C with the potential of detecting sub ppb (parts per billion) concentration levels of $C_3H_6O$. The very high $C_3H_6O$ sensing performance together with exceptionally high selectivity of the sensor ascribed to Pt nanoparticle and the $Co_3O_4$ section on the tip of the $Co_3O_4$/ZnO. Moreover, the formation of heterojunctions, synergistic gas sensing, and the catalytic activity of the proposed design enhances the response of the sensors. Accordingly, scanning electron microscopic (SEM), transmission electron microscope (TEM), energy-dispersive X-ray spectroscopy (EDS), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD) characterization, and the sensing mechanisms are comprehensively discussed at the conference.

Keywords: ZnO, $Co_3O_4$, composite MOXs, gas sensors
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