

# Hierarchical Dense Array of ZnO Nanowires Spatially Grown on ZnO/TiO<sub>2</sub> Nanofibers and Their Ultraviolet Activated Gas Sensing Properties

Mir Mehdi Hashemi, Alireza Nikfarjam\*, Hassan Hajghassem, Nahideh Salehifar

MEMS&NEMS Laboratory, Faculty of New Sciences & Technologies, University of Tehran, P.O. Box 14395-1561, Tehran, Iran

a.nikfarjam@ut.ac.ir

## Supporting information

### (i) Static measurement system

Gas-sensing assessments of sensors were performed by a static test system. The system had a data logger digital multi-meter to collect data, power supply, sealed glass container, gas inlet, gas outlet, heater, and UV irradiation lamp which was located inside the chamber. Electrical feed-through was connected to a monitoring system via RS 232. The UV lamp was (Model SKUVL-100) with  $3.25 \pm 1$  mW/cm<sup>2</sup> power. The space between the UV lamp and sensor was fixed to 2 cm. Fig. 1. shows the schematic diagram of the static gas testing setup

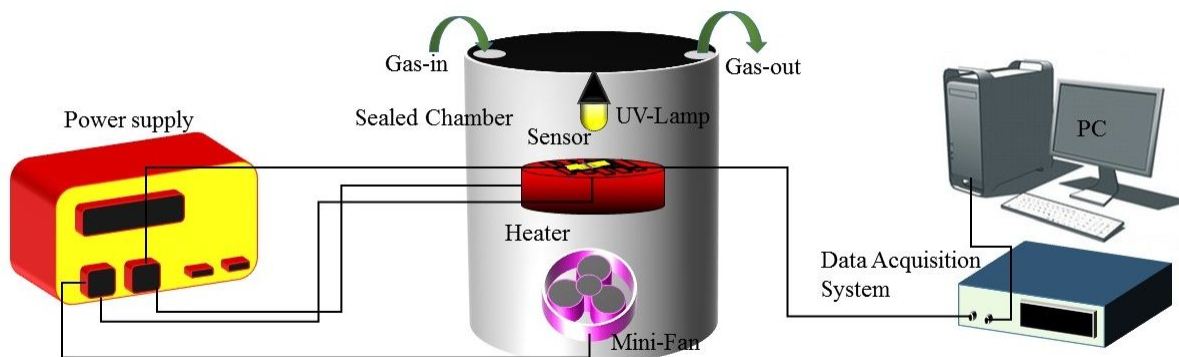
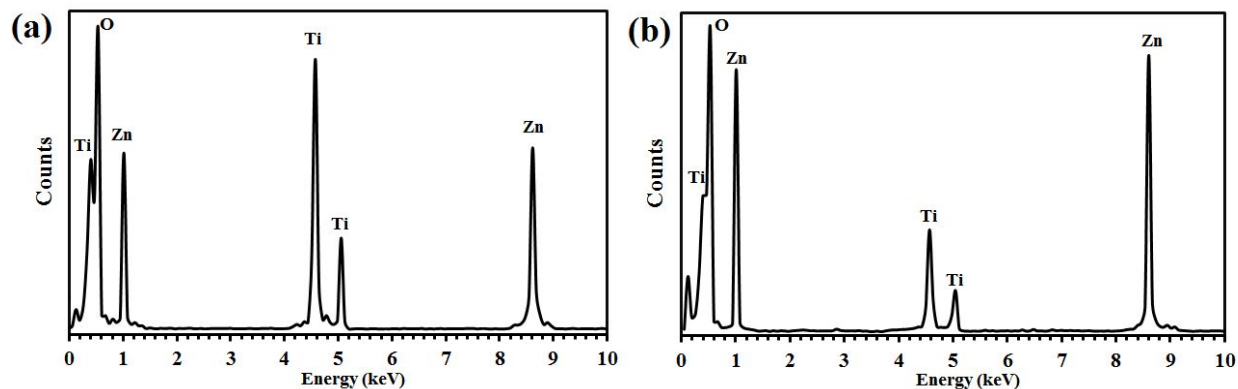


Fig. 1. Schematic diagram of the static gas testing system for gas sensing properties measurement

### (ii) EDX analysis

The elemental compositions of the as-prepared nanofibers were studied by EDX elemental analysis and the results are presented in Fig. 2(a) and 2(b). both hierarchical nanofibers and composite nanofibers exhibit peaks at about 1.0 keV and 8.6 for Zn, 4.5 keV, 0.4 keV, and 5.0 keV for Ti, and 0.5 keV for O, indicate the compositional validation of composite nanofibers and hierarchical nanofibers and high purity of materials.



**Figure. 2** EDX element analysis for (a) TiO<sub>2</sub>/ZnO composite nanofibers, and (b) hierarchical ZnO@TiO<sub>2</sub>/ZnO nanofibers.

### (iii) X- Ray photoelectron Spectroscopy (XPS) analysis

XPS was applied to determine the chemical composition of the sample. The analysis is obtained via irradiation of X-rays (Usually Mg K $\alpha$ ) in high vacuum. The absorption of X-ray photons leads to the emission of electrons. The binding energy of the emitted electrons can be calculated with the formula:

$$E_{\text{binding energy}} = E_{\text{photon}} - (E_{\text{kinetic energy}} + \Phi) \quad (1)$$

Where  $E_{\text{photon}}$  is the energy of the X-ray photons being used,  $E_{\text{kinetic}}$  is the kinetic energy of the electron and  $\Phi$  is work function which is related to the instrument. It must be noted that XPS is only sensitive to the top 10 nm below the surface of a sample.

The main carbon peak was used to calibrate the binding energy scale for each of the measured samples and was set to 285eV. All high-resolution XP spectra were fitted using combined Gaussian–Lorentzian peaks. The Shirley method was applied as background correction.