Controlled synthesis system for production of crystalline ZnO nanobelts and nanowires

*B. González Rolón, L. A. Vera Salas
*FIMEE Universidad de Guanajuato, Campus Salamanca Km 3.5 +1.8 de la carretera Salamanca-Valle de Santiago CP 36885, Comunidad Palo Blanco, Salamanca Gto. México
E-mail barbara@salamanca.ugto.mx

Interest in nanotechnology has greatly increased over the past years because of its wide implementation in technology, biotechnology and energy production. However the nature of these applications demands a very accurate and detailed manufacture method. Recently, industrialization of the ZnO has gained a lot of interest as an optoelectronic material due to its properties in the range of UV. Its energy gap is 3.37 eV, making this material suitable to insulate an electric field. The high electrical resistivity, which is derived from the previously mentioned energy gap, prevents current leakage. Alongside, the ZnO display another two key properties, its piezoelectric characteristics and the changes shown in its morphological configurations. Here we report the development of an automatized method to produce ZnO nanobelts and nanowires with a digitalized control of the reactor's temperature and pressure in a simple vapor transport system. Using this method we have successfully obtained nanobelts and nanowires with specific characteristics. The structural properties and composition of the samples were studied by X-ray diffraction (XRD) and the results demonstrated the formation of ZnO phase. Morphology of as-prepared products was characterized by scanning electron microscopy (SEM, LEO 1200).

The synthesis is based on thermal evaporation of ZnO powder (purity of 99.99% and melting point of 1975ºC). The oxide was placed in the middle of an alumina tube that was inserted in a horizontal tube furnace, where the temperature, pressure, and evaporation time were digitally controlled. In our research, except for the evaporation temperature, which was determined assuming the ZnO, we kept the following parameters constant: evaporation time of two hours, pressure of 300 torr and Argon flowing rate of 50 standard cubic centimeters per minute. Products were deposited onto a platinum plate, placed at the downstream end of the alumina tube. We have discovered that production of different nanostructures of ZnO can be made through the control of the process of synthesis. Figure 1 shows a diagram of how this method is controlled. As shown in figure 2, two types of one-dimensional ZnO nanostructure were identified on the basis of morphology. The product is observed as entangled, and in a place of the fiber changes the trajectory of its growth. It is bi-dimensional and the length of these nanostructures was in the range of several micrometers (about 3m- 0 2mm) and their diameters normally range from 50 to 120 nm. Beside, this shows another typical morphology of ZnO nanostructure, of which there are some straight wire-like products which all they have high yield and hardness.

Figures

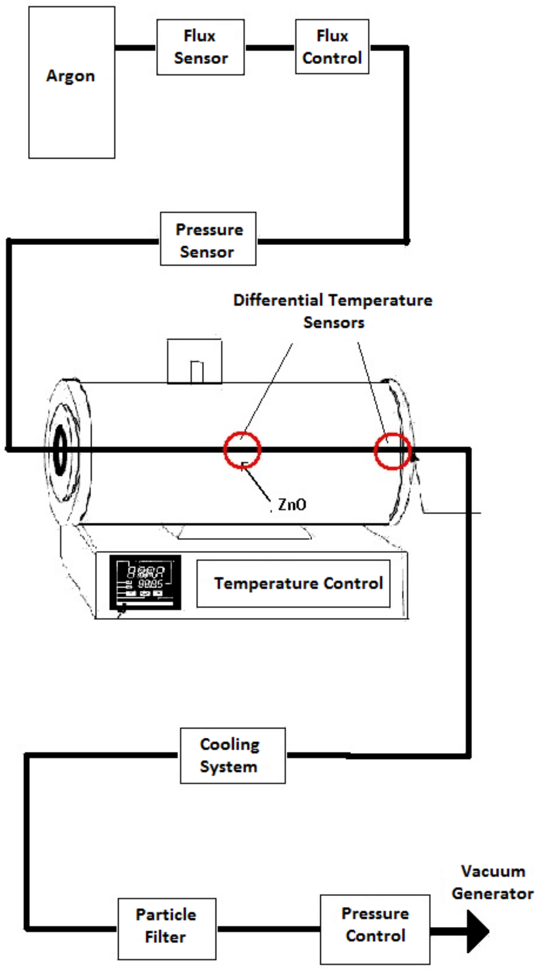

Figure1. Diagram of the automated production method for ZnO nanobelts and nanowires.

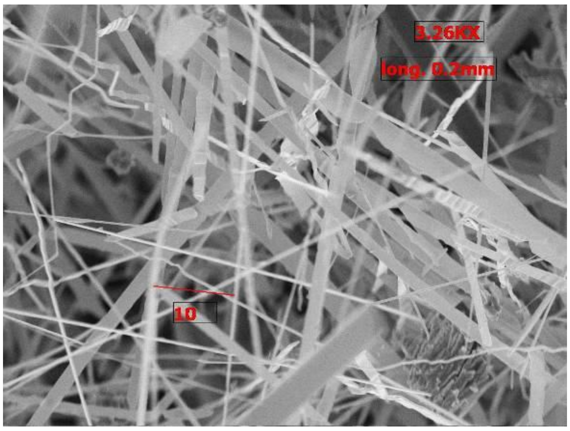

Figure2. SEM of obtained ZnO nanobelts and nanowires.

[1] Dehspandey. “Evaporation Process”: Semiconductors and Semimetals”. Academic Press. 1991.
[2] N. R. Franklin, Y. Li, R. J. Chen, A. Javey, and H. Dai, Appl. Phys. Lett. 79, 4571s2001d.