

NANOSTRUCTURES BASED ON TWO BINARY II-VI SEMINCONDUCTORS

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In this paper, we will report the synthesis of ZnO nanorods on in-situ grown ZnSe grains by using the simple chemical vapour deposition (CVD) method and elementary sources of Zn and Se. To our best knowledge, there is no report in growing of other Zn based nanostructures on in-situ synthesized ZnSe. The ZnO-ZnSe system has the advantage of carrier transfer between the two binary II-VI semiconductors with different energy levels for device applications [1], which cannot be achieved in the single compound semiconductor nanostructures.

With a suitable growth condition, single crystal ZnO nanorods grow on the well-defined bounded facets of the random shape ZnSe grains using Zn and Se powders without any metal catalyst as shown in Figure 1. The growth direction of ZnSe nanorods on a facet of a ZnSe grain is quite uniform because the lattice constant of the ZnSe is close to the c-axis of ZnO. TEM images of the ZnO-ZnSe products are shown in Figure 2. From our results, it is postulated that the synthesis of ZnO nanorods on ZnSe grains collected from the inner wall of the Zn powder crucible involved two stages. ZnSe grains are firstly synthesized and, in second stage, ZnO nanorods are formed on the facets of the grains. The formation of the ZnSe grain can be described as homogenous vapour-phase nucleation and the formation mechanism of ZnO nanorods is believed to be VS because no catalyst has been used in the synthesis and no droplet was observed at the tip of the nanorods.

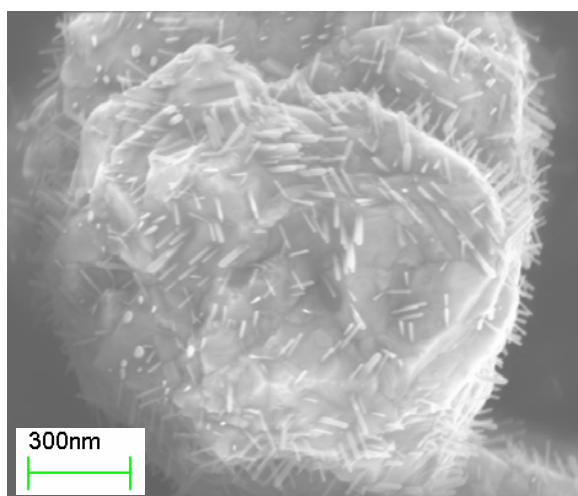


Figure 1 SEM of the nanorods on the grains.

The effects of the Se powder usage on the ZnO-ZnSe products and the photoluminescence of the products will be investigated. From the PL spectrum, the ZnO emission at the photon energy of $\sim 3.2\text{eV}$ cannot be observed because the ZnO emission is absorbed by the ZnSe grains and a large portion of the products is ZnSe grains. Consequently, ZnSe emission dominates the PL spectrum as shown Figure 3.

[1] P.V. Kamat, B. Patrick, J. Phys. Chem., vol.96, (1992), p.6829.

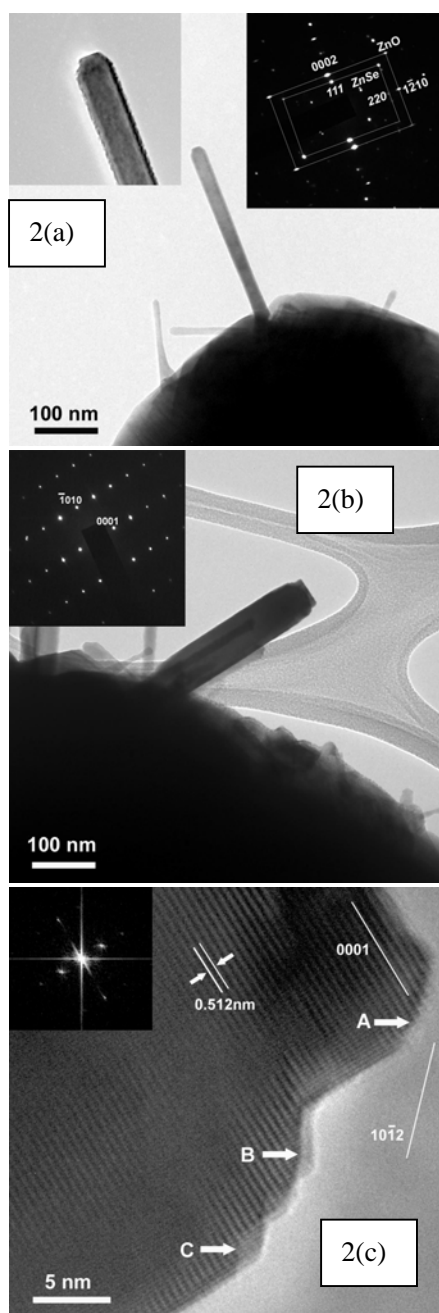


Figure 2 (a) Bright-field TEM image showing a ZnO nano-rod grown on a ZnSe grain. The upper right insert is the high magnification of the tip of the nano-rod. The upper left insert is a selected area diffraction pattern including the ZnO nano-rod and the ZnSe grain.

(b) Bright-field TEM image of another ZnO nano-rod showing clearly the tip of the nano-rod is flattened ended and faceted. The insert is the diffraction pattern from the nanorod indicating a [0001] growth orientation.

(c) High resolution TEM image of the tip of the nanorod in (b). The faceted surfaces, marked as A, B, C, are slightly off from the calculated $10\bar{1}2$ orientation indicating surface reconstruction. The insert is the power spectrum of Fourier transform of the image.

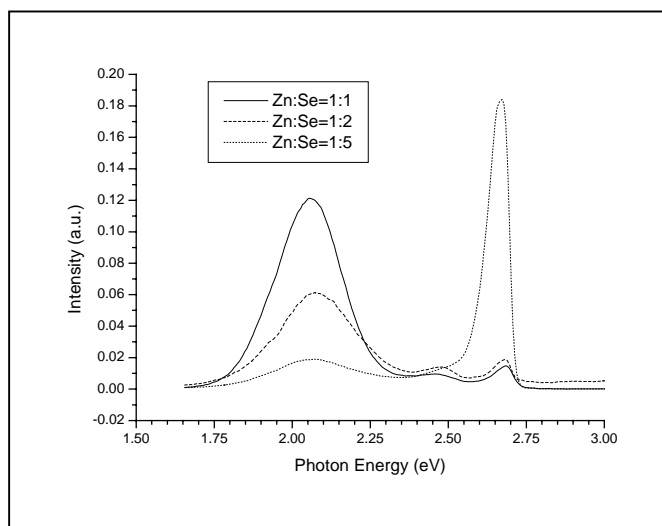


Figure 3 The PL of the ZnO-ZnSe products at 20K.