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# Fabrication and morphology of ZnO and ZnS nanoribbon heterostructure

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One-dimensional metal oxides and sulfides nanomaterials have attracted much attention due to their potential applications in nanoscale devices such as optoelectronics, sensors, and actuators. ZnO and ZnS are semiconductors with large band-gap (3.35 eV and 3.68 eV, respectively) that have been studied extensively [1,2]. Thermal evaporation method has been demonstrated to be effective in synthesizing various types of these materials including nanobelts, nanoribbons, nanotubes and nanowires. Ma and et al. have proposed a road map for the controlled synthesis of various types of CdSe for industrial applications of nanomanufacturing, by simply controlling the substrate pressures and temperatures [3]. In this report, we present TEM study of ZnO and ZnS nanoribbon heterostructures.

Thermal evaporation method was used to fabricate ZnO/ZnS nanoribbons heterostructures. Commercial ZnS powders (Alfa Aesar) were loaded onto a small alumina boat and then positioned at the center of the alumina tube. A silicon wafer, coated with gold nanoparticles of diameter ~ 2nm, was used as a substrate to collect ZnO/ZnS nanoribbons. Oxygen was added to the carrier gas, Ar, which was introduced at a flow rate of 100 standard cubic centimeters per minute. The temperature of the alumina tube was held at 1050°C for 2h and the pressure was kept at 200 Torr. The uniform and gray film was clearly visible on Si substrate.

Fig. 1(a) and (b) show the Annular Dark Field (ADF) STEM image of nanoribbon at two different magnifications, exhibiting two phases or layers in the nanoribbons which grow along $[2\bar{1}\bar{1}0]$ with $\pm(01\bar{1}0)$ surfaces [1] as shown in the selected-area electron diffraction pattern (Fig. 1(b) inset). A gold cap at the tip of a nanoribbon is clearly visible and also confirmed by the Energy-Dispersed X-ray (EDX) technique (Fig. 2). Fig. 1(c) shows the CBED patterns of two layers, showing the same growth directions. The formation of parallel ZnO and ZnS nanoribbons was clearly evident in the EDX elemental maps shown in Fig. 2. EDX and EELS were collected simultaneously in STEM mode. Spatially resolved EELS also confirmed the presence of two layers. In the sulfur rich region little or no oxygen was found. Further discussion on the growth mechanism will be presented and comparisons of EELS with XAS measurements will be discussed [4].

References

[1] Y. Ding and Z. L. Wang, J. Elec. Micro. 54 (2005) 287.
[2] X. T. Zhou et al., J. Appl. Phys. 98 (2005) 024312.
[3] C. Ma and Z. L. Wang, Adv. Mat. 17 (2005) 2635.
[4] This research was supported by the NSERC.

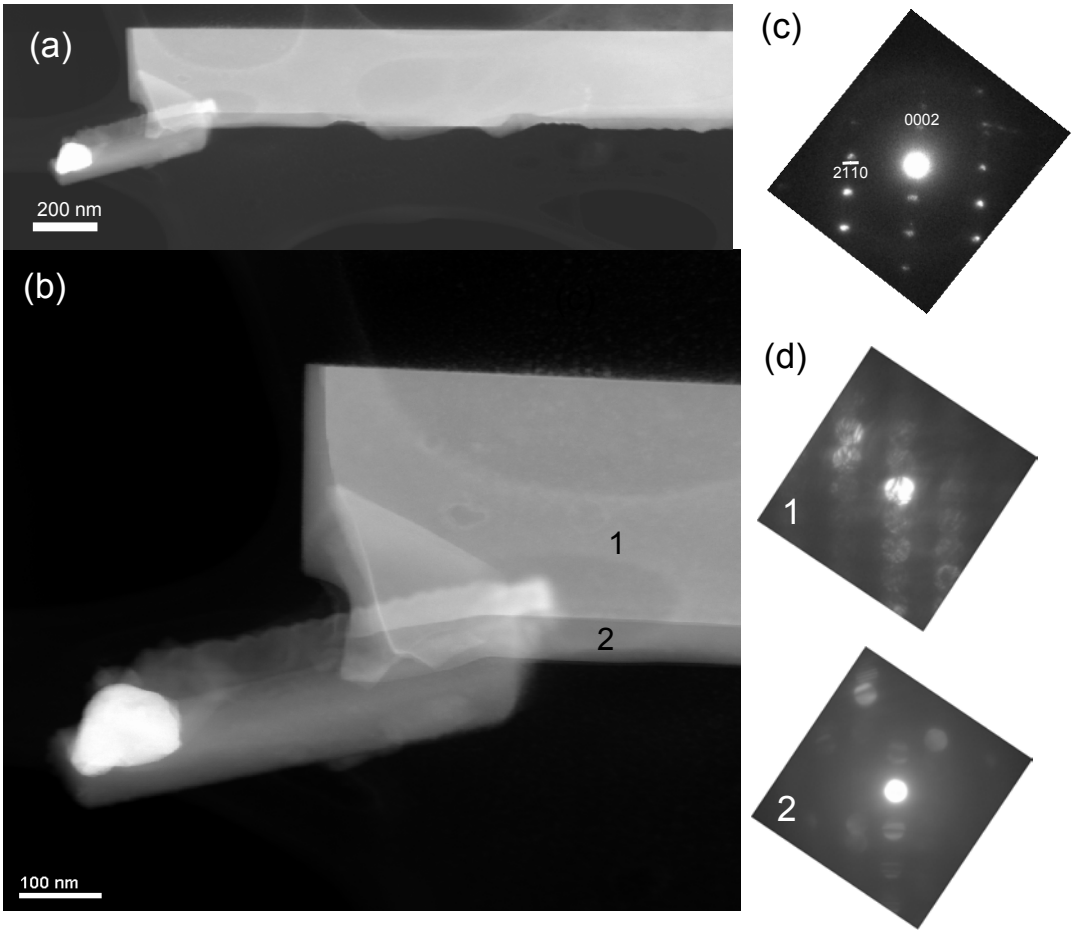


FIG. 1. (a) and (b) ADF STEM image of ZnO/ZnS nanoribbons and corresponding SAED pattern in (c). (d) CBED patterns from layers 1 and 2.

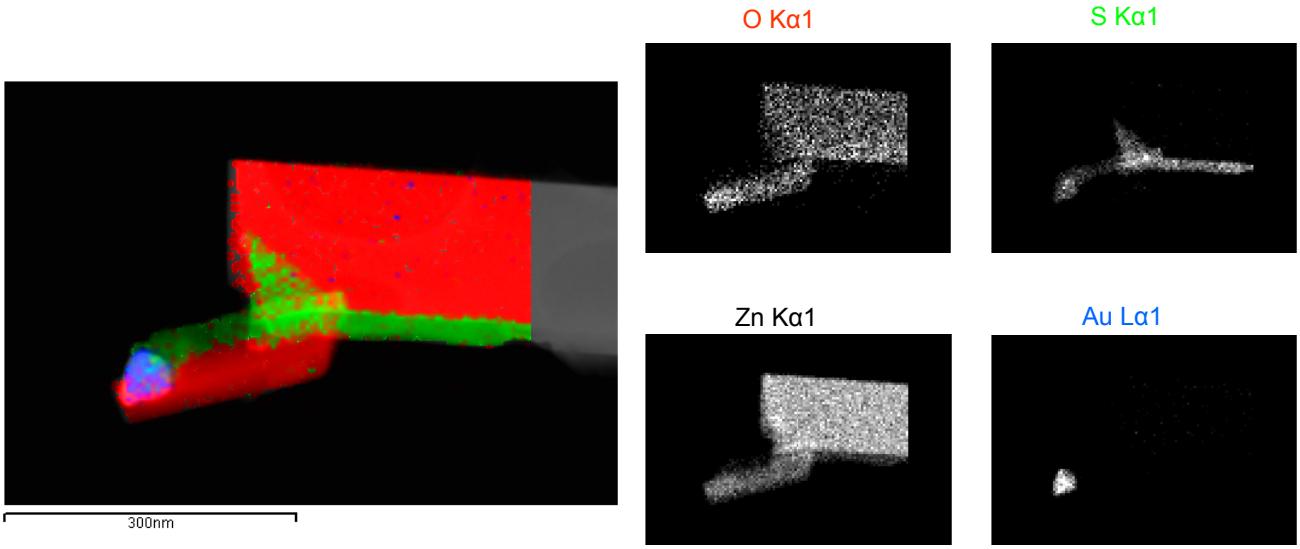


FIG. 2. Energy-dispersive X-ray element maps showing two distinct regions of ZnO (red) and ZnS (green). Au catalyst, located at the tip of nanoribbon, is shown in blue.

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