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# Self-Assembled Zn/ZnO multilayer nanowires

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Zinc oxide (ZnO) is a versatile smart material that has key applications in catalysts, sensors, piezoelectric transducers, transparent conductors, and surface acoustic wave devices. A variety of quasi-one-dimensional ZnO nanostructures, such as nanowires and nanobelts, have been synthesized, and they have been used for fabricating nanoscale lasers, field effect transistors, gas sensors, cantilevers, and resonators [1]. Recently, Zn-ZnO core-shell nanobelts and nanotubes have also been synthesized, and expected to have a potential application in nano-electromechanical systems [2, 3]. Metallic zinc nanowire is a promising candidate for interconnects in future nanodevices. The microstructure of the interconnect materials at nanoscale will strongly affect the quality and lifetime of the nanodevices. Thus, it is of interest to study the microstructure and thus control the microstructure in one-dimensional nanoconnectors. Here we report the TEM study of template synthesis of self-assembled Zn/ZnO multilayer nanowires by electrochemical deposition.

Zinc nanowires were fabricated by electrodepositing Zn into commercially available polycarbonate membrane (PCM )(SPI supplies). The electrolyte was prepared by dissolving 5.4 g $ZnCl_2$ into 200 ml distilled water, then mixed with 40 ml saturated KCl. By controlling the temperature, potential, additive of chemicals, we successfully synthesized self-assembled Zn/ZnO multilayer nanowires.

Figure 1 shows a low magnification STEM dark field image of a self-assembled Zn/ZnO multilayer nanowire. The growth direction of the nanowire is also indicated. It is clear that the Zn and ZnO form a periodic multilayer structure in the nanowire. EDX analysis shown in Figure 1(b) confirms that the dark contrast layers in the wire are zinc oxide (ZnO). Single crystal Zn nanowires have three growth orientations: $[1\bar{2}10]$, $[0\bar{1}10]$ and [0001]. Self-assembled Zn/ZnO multilayer structure always formed in $(0001)_{Zn}//(0001)_{ZnO}$ plane with growth direction of $[0\bar{1}10]$. Shown in Figure 2 is a HRTEM image of the Self-assembled Zn/ZnO multilayer structure in a nanowire growing along $[01\bar{1}0]$ direction. The ZnO layer thickness is about several atomic layers. From the diffraction pattern inset, we can see that the ZnO and the Zn have an epitaxial relationship of $[2\bar{1}\bar{1}0]_{Zn}//[2\bar{1}\bar{1}0]_{ZnO}$, $(01\bar{1}0)_{Zn}//(01\bar{1}0)_{ZnO}$. We believe the formation of the self-assembled Zn/ZnO multilayer structure attributes to the superior stability of the ZnO ± (0001) polar interfaces, which is a forefront research in today's surface physics [1]. Shown in Figure 3 (a) is perpendicular domain on the edge which has the self-assembled Zn/ZnO multilayer structures; and sometimes a close loop of ZnO particle can also be found inside Zn as indicated in Figure 3(b).

References

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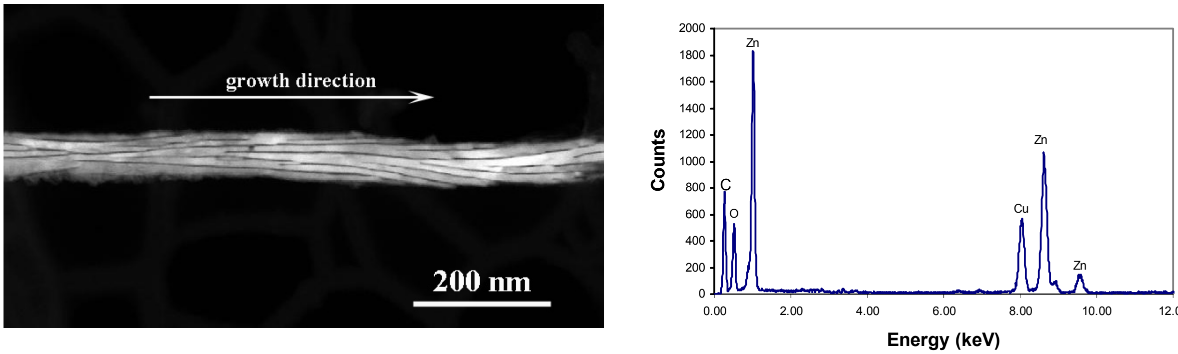


Figure 1. (a) A low magnification STEM dark field image of a self-assembled Zn/ZnO multilayer nanowire and (b) EDX analysis of zinc oxide (ZnO).

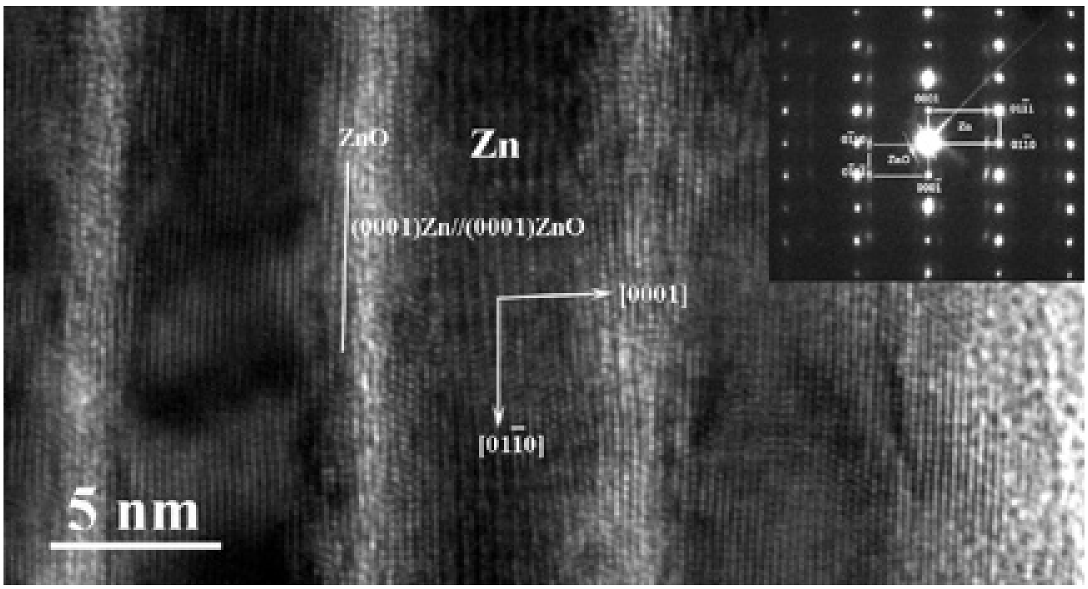


Figure 2. HRTEM image of the Self-assembled Zn/ZnO multilayer structure in a nanowire growing along [01$\bar{1}$0] direction.

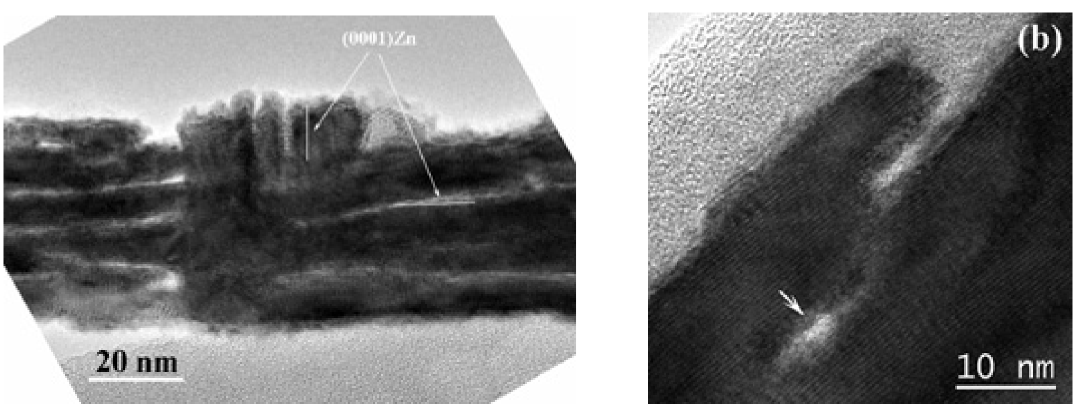


Figure 3. (a) A perpendicular domain on the edge has the self-assembled Zn/ZnO multilayer structures, (b) a close loop of ZnO particle can also be found inside Zn (indicated by white arrow).

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