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Synthesis and Characterization of ZnO Encapsulated Hematite Nanowires and Nanobelts

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One dimensional nanocomposite materials have attracted great interest because of their novel physical and chemical properties and their potential applications in nanoscale electronic devices, photovoltaics, sensing, and nanocatalysts. Alpha Fe_2O_3 (hematite) nanowires are of interest because of their potential applications in magnetic recording and as a catalyst for the dehydrogenation of ethylbenzene to styrene [1]. Moreover, α-Fe_2O_3 composite materials have attracted interest as gas sensors [2]. In this paper we report the synthesis of aligned ZnO coated α-Fe_2O_3 nanowires and nanobelts by two-step synthesis process.

The α-Fe_2O_3 nanowires and nanobelts were synthesized by direct thermal oxidation of Fe substrates [3] in an open air tube furnace for 20 hours at 650^o C. The as synthesized α-Fe_2O_3 nanowires and nanobelts were then loaded into a tube furnace with a ZnO source material located at the center of the tube furnace. The furnace was then heated to 1000^o C with argon and oxygen flowing through the tube, carrying the evaporated Zn/ZnO molecules to lower temperature where they deposited onto the α-Fe_2O_3 nanowires and nanobelts. A field emission SEM equipped with an energy dispersive X-ray spectrometer and a Robinson backscattered electron detector was used to characterize the morphology, composition and size distribution of both the uncoated α-Fe_2O_3 nanowires and nanobelts and the ZnO-Fe_2O_3 nanocomposites.

Figure 1a shows a SEM image of the ZnO coated α-Fe_2O_3 nanowires. The as synthesized α-Fe_2O_3 nanowires were aligned and grew perpendicular to the substrate with an average length and diameter of 10.0 μm and 0.3 μm, respectively. After growth of ZnO, the α-Fe_2O_3 nanowires maintained their original growth directions. Figure 1b shows a high magnification SEM image of the nanowires, clearly revealing the presence of continuous coating of ZnO nanoparticles. The diameters and the shapes of the original α-Fe_2O_3 nanowires were significantly modified; the average diameter of the ZnO/Fe_2O_3 was about 0.55 μm. Figure 2a shows a SEM image of the ZnO coated α-Fe_2O_3 nanobelts. Similar to that of the α-Fe_2O_3 nanowires, after growth of ZnO, the orientation and the general morphology of the α-Fe_2O_3 nanobelts did not change much. The average length and width of the nanobelts before the ZnO deposition were measured to be approximately 12.0 μm and 1.5 μm, respectively; the average width of the ZnO/Fe_2O_3 was about 1.8 μm. Figure 2b shows a high magnification SEM image of the nanobelts. It can be clearly seen that during the synthesis process ZnO encapsulated the α-Fe_2O_3 nanobelts. Detailed examination showed that even thin ZnO nanowires grew out from the ZnO-Fe_2O_3 composite nanobelts. The detailed synthesis-structure relationships and how the morphology of the ZnO encapsulation varies with the experimental parameters will be discussed [4].

References

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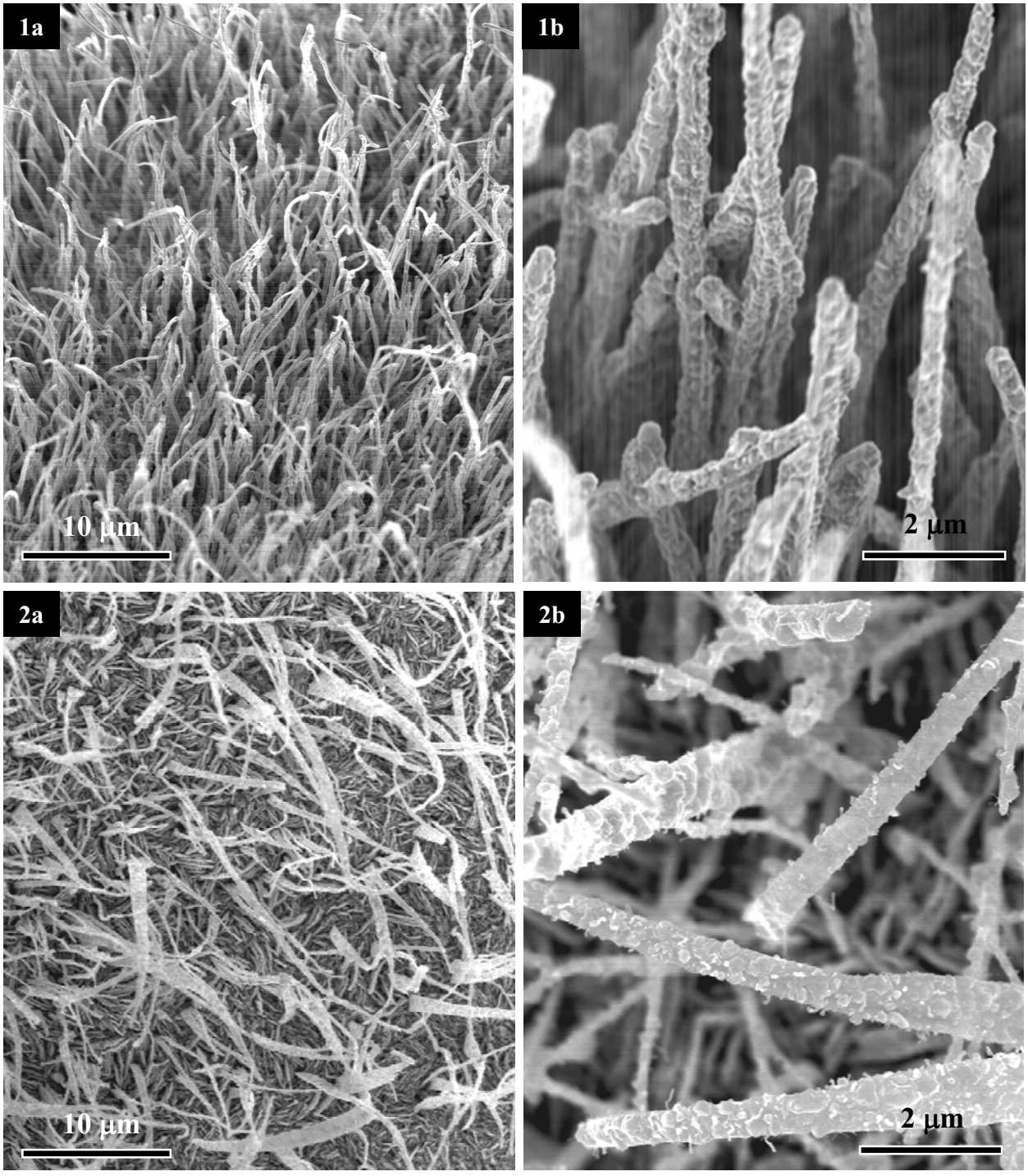

FIG. 1. Low (a) and high (b) magnification SEM images of ZnO encapsulated α-Fe_2O_3 nanowires.
FIG. 2. Low (a) and high (b) magnification SEM images of ZnO encapsulated α-Fe_2O_3 nanobelts.

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