Microtructural Characterization of Encapsulated Phase Change Nanoparticles as Biosensors

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Encapsulated nanopartticles, the core-shell structure, have attracted more attentions due to the applications as biosensors in that the physics and/or chemistry changes for both core and shell materials when working as cancer detection [1-3]. As a typical solid to liquid phase change material (PCM), bismuth shows unique thermophysical properties that the absorbed thermal energy is used to melt the solid phase without temperature rising. In this work, a multiplexed biosensor, silica encapsulated bismuth nanoparticles, has been synthesized by thermal decompositions of organometallics procures [3]. The melting points of pure encapsulated Bi nanoparticles and encapsulated Bi nanoparticles after hybridization with target ssDNA have been measured by DSC.

The microstructure was characterized by transmission electron microscopy (TEM), scanning transmission electron microscopy by field emission transmission electron microscope FEI Tecnai F30/ST. The chemistry was identified by x-ray energy dispersive spectroscopy (EDS) and electron energy-loss spectroscopy (EELS). Elemental mappings were obtained by Gatan Image Filter (GIF).

Fig. 1 shows the morphology of nanoparticles and selected area electron diffraction (SAED) pattern from an individual particle. TEM image shows that the particle size is quite uniform with about 20 nm shell. The indexed result gives the evidence of bismuth of the rhombohedral structure with a = 0.4536 nm and c = 1.185 nm. Meanwhile, the high angle annular dark field (HAADF) image, Fig 2(a), displayed the core shell structure of the particles as well. Fig. 2 (b) and (c) are elemental mappings of oxygen and silicon respectively. It can be seen clearly that the shell is consisted of O and Si. EDS spectrum from the center of particle in HADDF image shows in Fig. 2 (d). Bismuth peaks can be seen clearly.

References

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[3] Z. Ma, Y. Hong, M. Zhang and M. Su, *Appl. Phys. Lett.*, 95 (2009) 233101.
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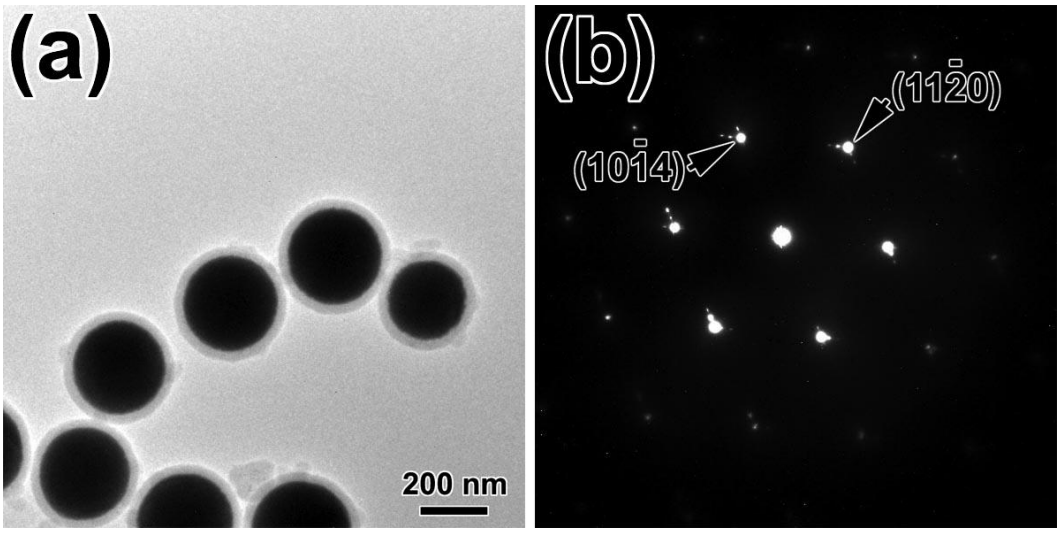

FIG. 1. TEM image (a) showing the morphology of particles, in which the size is quite uniform, and core-shell structure can be seen clearly. The indexed SAED pattern (b) showing the rhomohedral structure of bismuth with $[10\bar{1}0]$ zone axis.

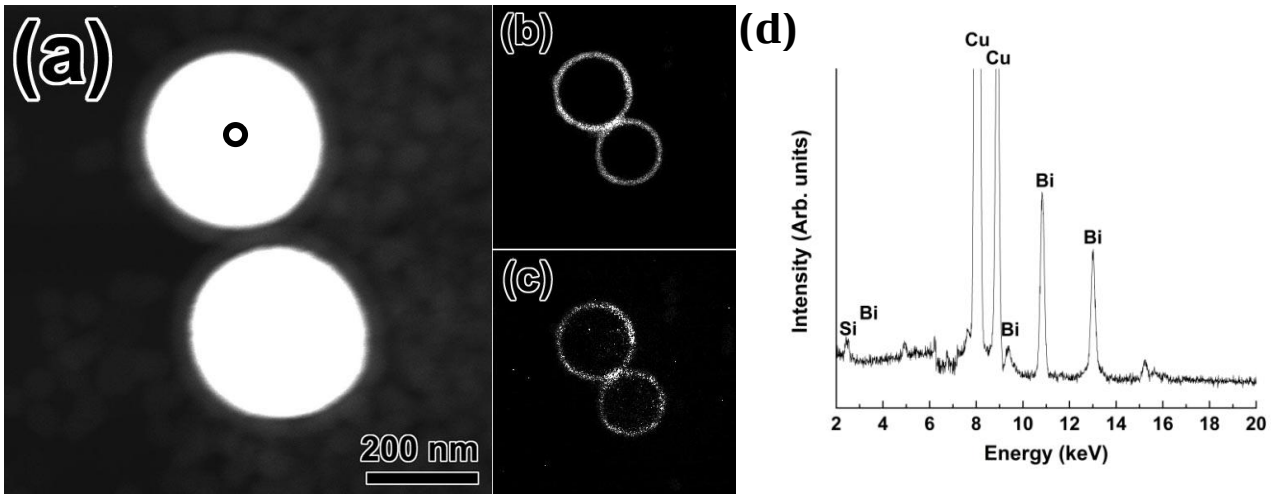

FIG. 2. (a) HAADF image of nanoparticles, displaying the core-shell structure. The spot in the center of the particle indicates the area for EDS spectrum in (d); (b) oxygen and (c) silicon elemental mappings of nanoparticles, showing the shell is composed of O and Si; (d) EDS spectrum of nanoparticle from the spot point at (a).