Supporting Information

# Metal-Redox Synthesis of MnBi Hard Magnetic Nanoparticles

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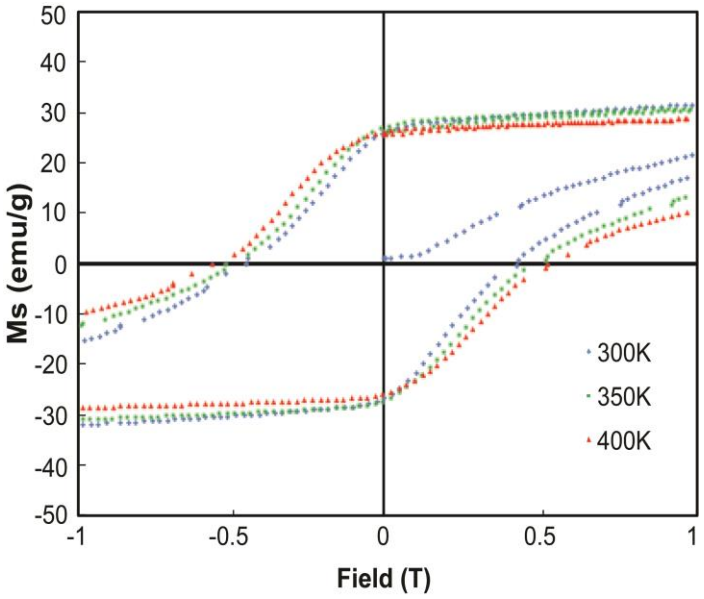
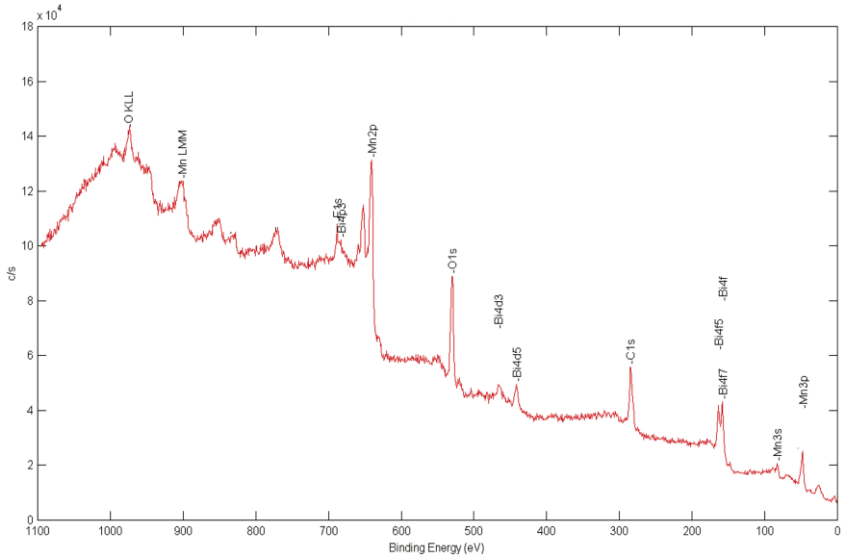



**S.I Figure 1.** Temperature dependent M-H loop of MnBi nanoalloys displaying increased coercivity at higher temperatures.

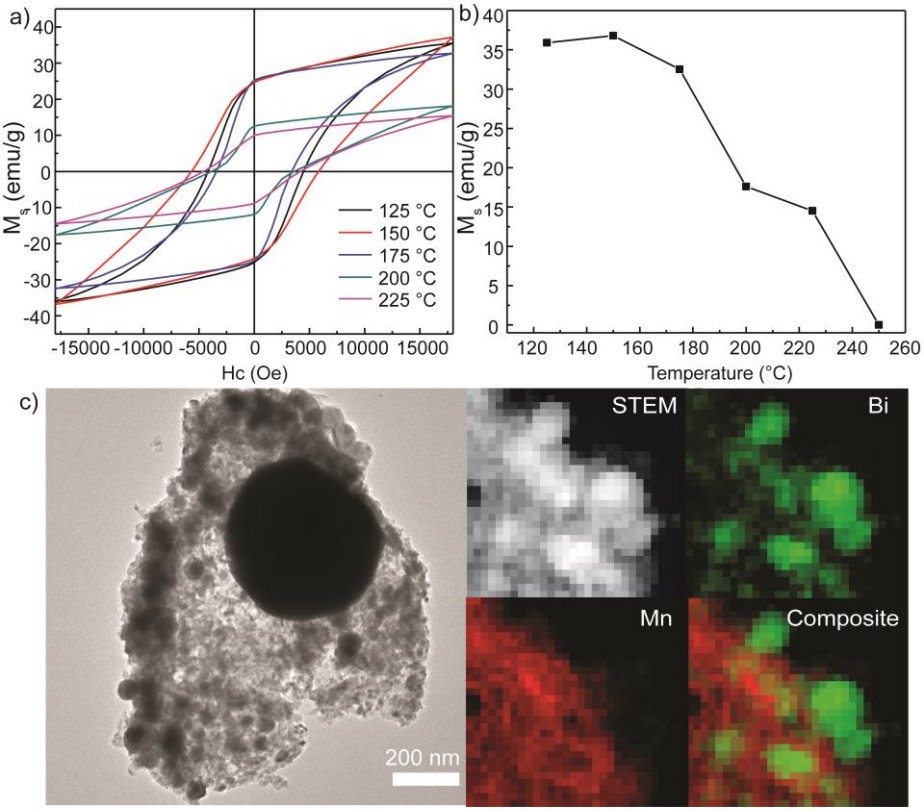
The synthesized MnBi nanoalloys display higher coercivity at higher temperatures much like it's bulk counterparts. There is an increase of 1000 Oe from 300K to 400K, making this material promising for high temperature applications.




**S.I. Figure 2.** X-ray photoelectron Spectroscopy (XPS) spectrum of shiny sphere MnBi particle.

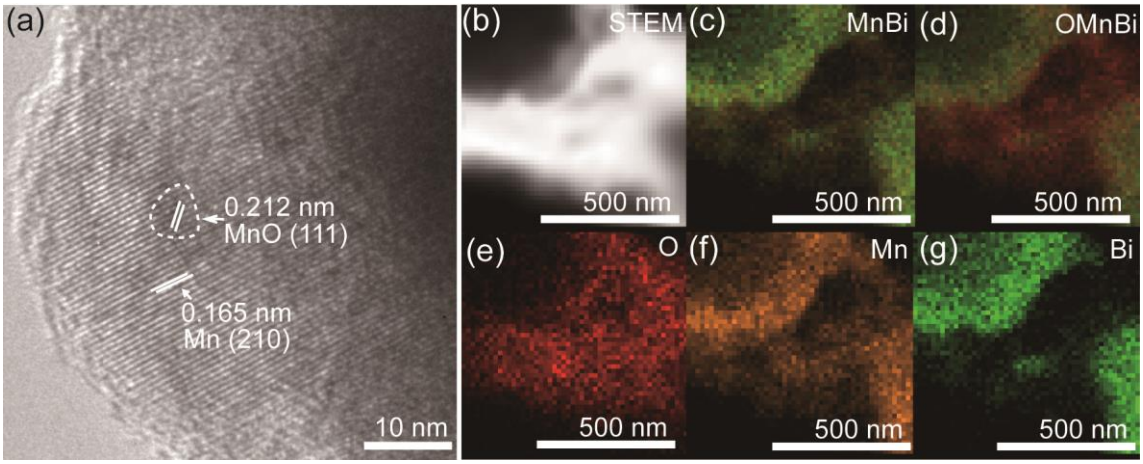
XPS spectrum obtained on the MnBi particles with the fast ramp rate. It indicates high manganese counts comparative to the bismuth, which suggests that there is a thick manganese shell on the surface of the particles. There is also oxygen present, showing

that any of the manganese deposited on surface rapidly oxidizes during clean up of particles.




**S.I. Figure 3.** a) M-H loops of MnBi nanoparticles dependent on solvent annealing temperatures. b) Summary of $M_s$ based on post synthesis solvent annealing temperature. c) Transmission electron microscopy (TEM) images and elemental mapping of particles after solvent annealing at 270 °C.

To try to remove any excess bismuth from the final particles, a solvent annealing step after synthesis was attempted. S.I. figure 3a,b shows M-H loops and summary of saturation of particles dependent on solvent annealing temperature. At lower temperatures, such as 125 °C and 150 °C, the saturation stays the same, not improving final particles. Once solvent annealing temperatures reach 175 °C and above, the magnetic properties of the particles are damaged, and completely destroyed by 250 °C. TEM images and elemental mapping shown in S.I. figure 3c display particles that were treated by 250 °C solvent annealing, showing complete destruction of the MnBi particles.




**S.I. Figure 4.** a) High-resolution TEM of MnBi sample (the injection ratio of Mn and Bi: 10:1). b) Scanning TEM of MnBi sample (the injection ratio of Mn and Bi: 10:1). c-g) elemental mapping of MnBi sample (the injection ratio of Mn and Bi: 10:1).

S.I. Figure 4a supplies the high-resolution TEM of MnBi sample with the injection ratio of Mn and Bi 10:1. It shows that Mn shell with (210) plane exist in the edge of MnBi. At the same time, some Mn is also oxidized and form MnO. The state of MnO exist as (111) plane. Elemental mappings further prove that MnBi phase is coated by Mn shell and Mn shell is also oxidized by oxygen.