Electronic Supplementary Material

Dependency of magnetic microwave absorption on surface architecture of $Co_{20}Ni_{80}$ hierarchical structures studied by electron holography

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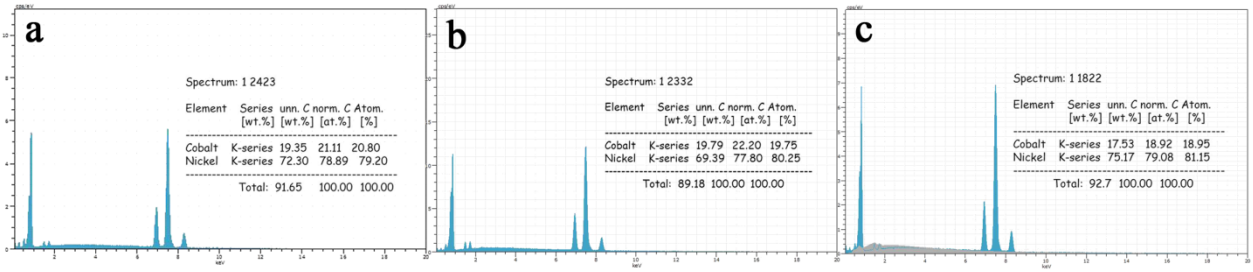

Fig. S-1 EDS patterns of the ball-like particles (a), chains (b), urchin-like microspheres (c).

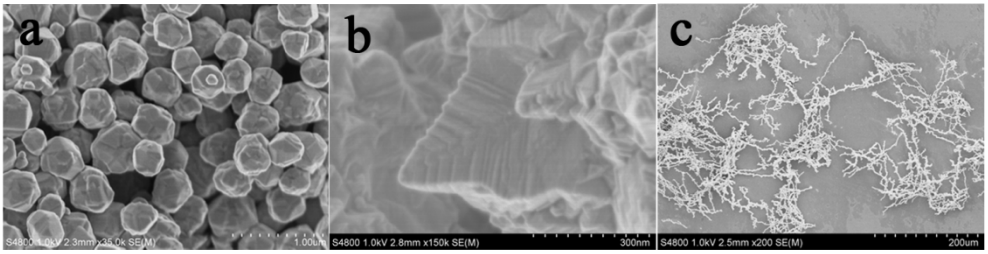

Fig. S-2 (a) SEM images of the $Co_{20}Ni_{80}$ alloy without NaOH of the ball-like particles. (b) The enlarged view of the spike on the surface of urchin-like microsphere. (c) The low multiple SEM image of the chain-like morphology.

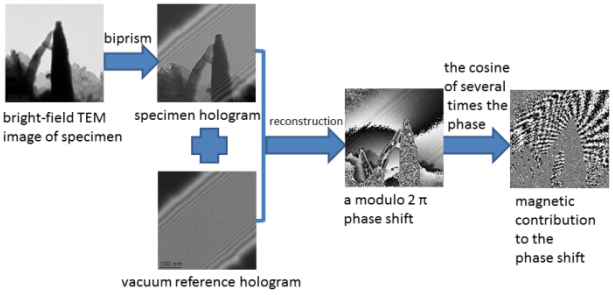

Fig. S-3 Schematic diagram of processing steps required to convert a recorded electron hologram into a magnetic contribution of phase image.

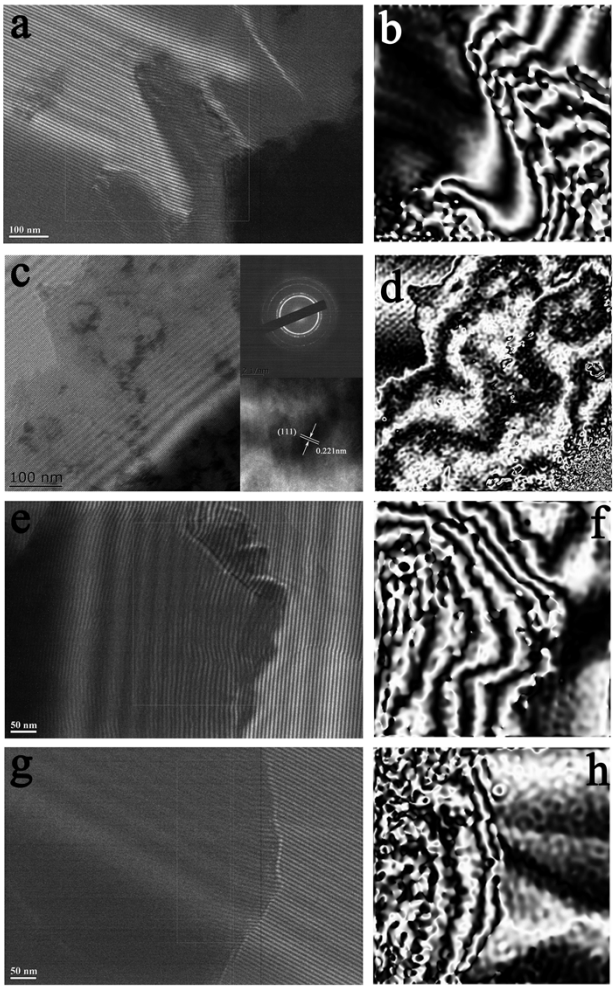

Fig. S-4 Bright-field TEM images of the four different morphology $Co_{20}Ni_{80}$ alloy slices (a, c, e, g). And the corresponding inner magnetic contributions to the phase shift by electron holography of the four different morphology $Co_{20}Ni_{80}$ alloy (b, d, f, h). The insets in Fig. c show the high-resolution image and the selected-area electron diffraction of the flower-like microsphere. The $Co_{20}Ni_{80}$ alloy slices with 80nm thickness were made by cutting the microspheres using ultramicrotome. (We measured the phase shift and calculated the corresponding area where magnetic flux pass through by considering specimen thickness of 80 nm, obtained that the magnetization values of flower-, urchin-, ball-, and chain-like are 841.4, 765.7, 643.1 and 617.1 emu/cc, respectively. Considering the unit of emu/cc and sample density of 7.89 g/cc, we found good agreement with the SQUID results, i.e, 105.62, 96.41, 83.08 and 79.11 emu/g, respectively).

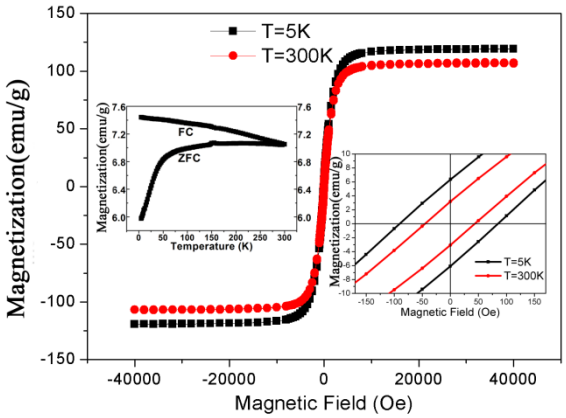

Fig. S-5 Hysteresis loop of the flower-like microspheres measured at 5 K and 300 K, respectively. The right inset shows the enlarged view of the hysteresis loops between -160 Oe and 160 Oe and the left inset shows the Field-cooled (FC) and zero-field-cooled (ZFC) curves for flower-like microspheres at 100 Oe.