Electronic Supplementary Material (ESI) for Chemical Communications

Controllable Synthesis of Cu-Ni Core-Shell Nanoparticles and Nanowires with Tunable Magnetic Properties

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Experimental Section

Chemicals. Nickel(II) acetylacetone ($Ni(acac)_2$, >98%), oleylamine (80−90%) and trioctylphosphine oxide (TOPO, 90%) were purchased from Acros Organics. Toluene, n-hexane, acetone, ethanol, and CuBr were purchased from Sinopharm Chemical Reagent Co., Ltd. All of these chemicals were used as received without any further purification.

Synthesis of Cu nanocubes. All of the syntheses were carried out with a protective atmosphere of argon. Typically, 0.6 mmol of CuBr and 1.5 mmol of TOPO were dissolved into 7 mL of oleylamine in a three-necked flask by strong magnetic stirring at 80 ^{o}C for 15 min. Then the resulting solution was quickly heated up to 260 ^{o}C and refluxed at this temperature for 1 h before cooling down to room temperature naturally. Excess hexane was added to the bright reddish solution, and the products were precipitated out by centrifugation. The products were purified by three rounds of centrifugation and redispersion in hexane prior to being finally dispersed into 10 mL of hexane by ultrasonication for 15 min.

Synthesis of Cu-Ni core-shell nanocubes. The as-synthesized Cu nanocubes dispersed in 10 mL of hexane was mixed together with 7 mL of oleylamine and 0.05 mmol of $Ni(acac)_2$. Hexane was distilled away by heating at 85 ^{o}C with argon purge and magnetic stirring for 30 min. Then the mixture was heated up to 190 ^{o}C and kept at this temperature for 1 h. The aftertreatment steps are the same as those for preparing Cu nanocubes.

Synthesis of Cu-Ni core-shell tetrahexahedron nanoparticles. Except that the amount of $Ni(acac)_2$ was increased to 0.2 mmol, the other steps are the same as those for preparing Cu-Ni core-shell nanocubes.

Synthesis of Cu-Ni core-shell nanowires. In a typical synthesis, a mixture of 5 mL of oleylamine, 0.5 mmol of $Ni(acac)_2$ and 0.3 mmol of $CuCl_2 \cdot 2H_2O$ was decanted into a three-necked flask and kept under a flow of high-purity argon gas at 130 ^oC for 15 min with strong magnetic stirring . Then the resulting solution was slowly injected into 6 mL of 1-octadecence by a syringe pump at 185 ^oC for 3 h. After cooling to room temperature, the obtained products were washed using the mixture of hexane and ethyl alcohol, separated by centrifugation and dried in vacuum.

Characterization. The sample for transmission electron microscopy (TEM) analyses were prepared by dropping the nanoparticle suspensions in hexane onto a 200 mesh Mo grid coated with Formvar Support film and carbon film before drying at room temperature under ambient condition. TEM, high-angle annular dark-field (HAADF) imaging and EDS analyses were carried out using a FEI F20 transmission electron microscope operating at 200 kV. Selected area electron diffraction (SAED) analysis and corresponding TEM image collections were carried out using a JEOL-2100 transmission electron microscope operating at 200 kV. The scanning electron microscopy (SEM) images were collected on Hitachi SU-70 scanning electron microscope operating at 15 kV. X-ray diffraction measurements were taken on a Panalytical X'pert PRO diffractometer using Cu Kα radiation, operating at 40 kV and 30 mA. Magnetic property study was carried out with a Physical Property Measurement System (PPMS-9, Quantum Design).

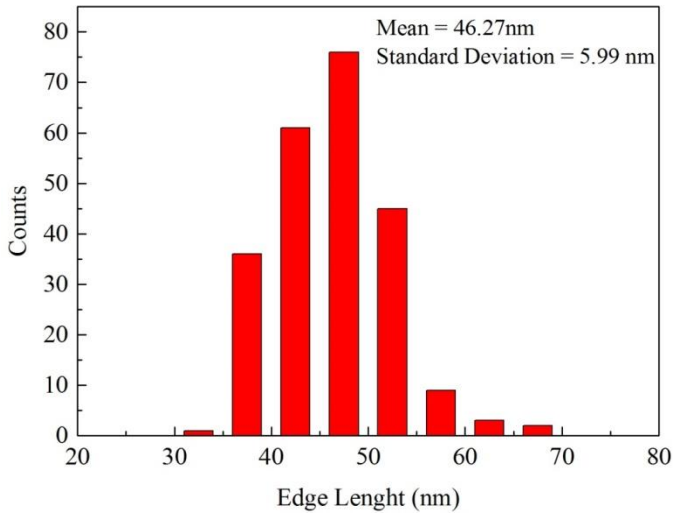

Fig. S1 Statistic result of the edge length distribution of the typical Cu nanocube seeds.

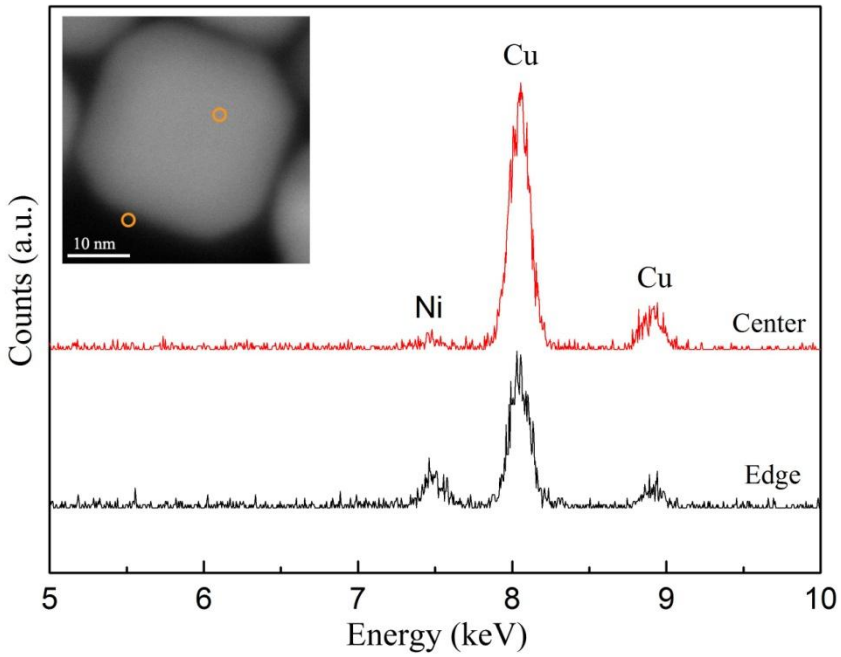

Fig. S2 EDS analysis on the center and edge of a Cu-Ni core-shell nanocube.

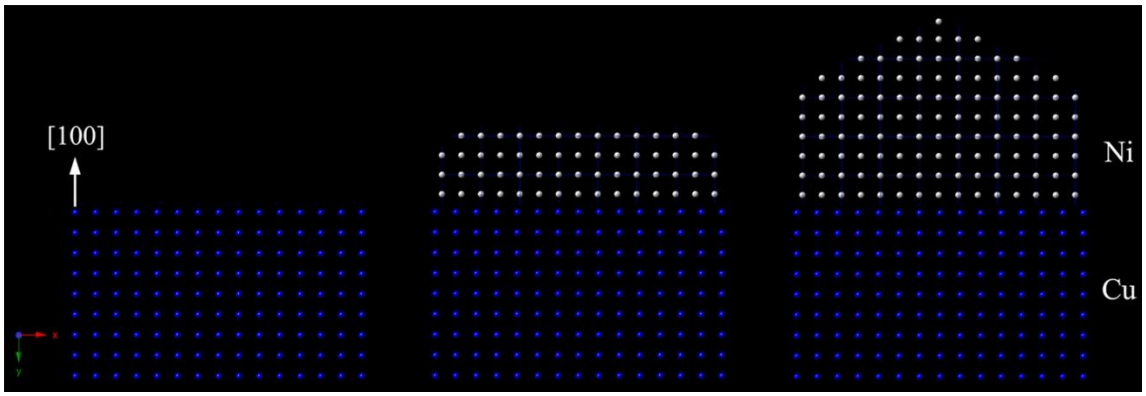

Fig. S3 Simulated reticular pattern and interface of Cu (blue) and Ni (white).

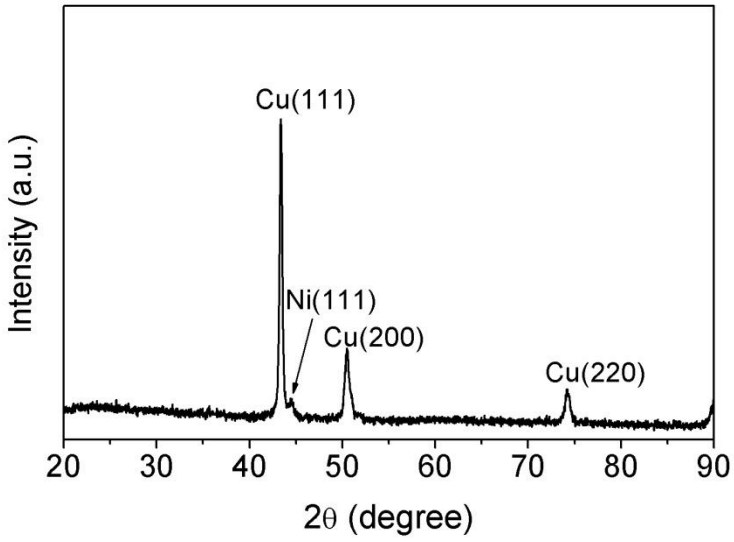

Fig. S4 XRD pattern of Cu-Ni core-shell nanowires with a corn-like morphology.

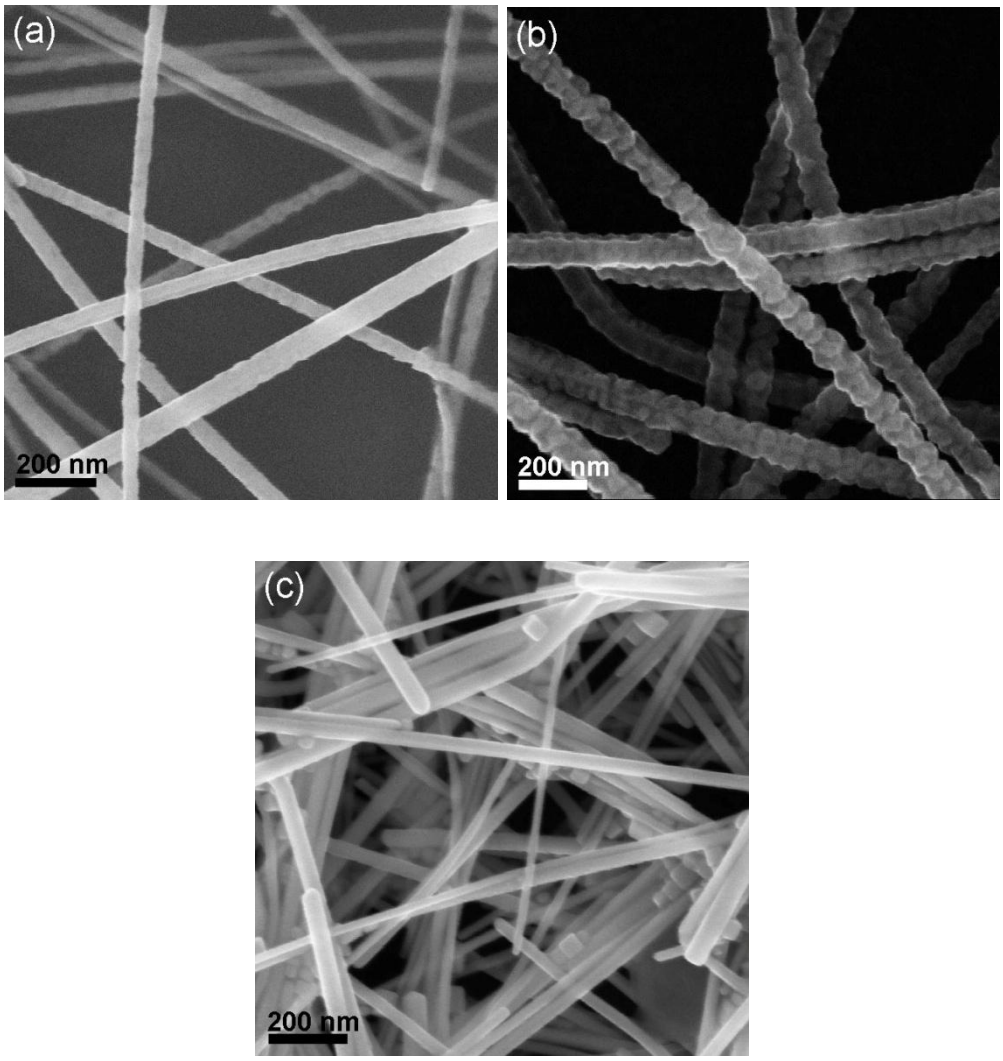

Fig. 5 SEM images of the Cu-Ni core-shell nanowires synthesized using different stirring speeds. (a) 200 rpm. (b) 400 rpm. (c) 850 rpm.

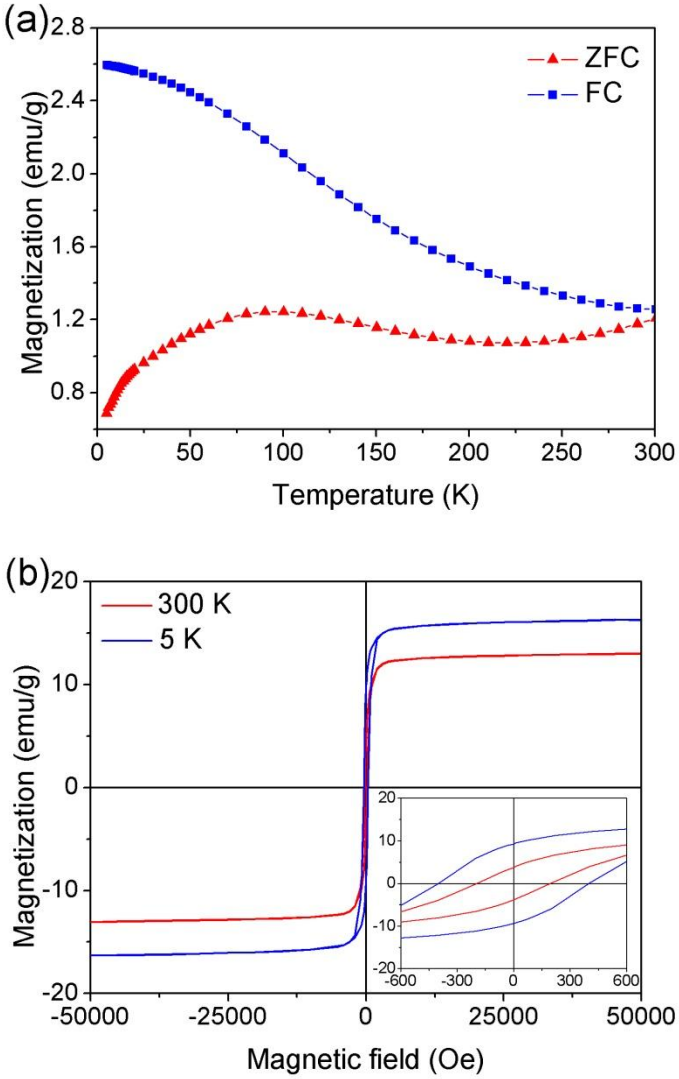

Fig. 6 ZFC-FC curves obtained in a measuring field and cooling field of 100 Oe (a) and magnetic hysteresis loops (b) of the corn-like Cu-Ni core-shell nanowires.