Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Shape-Controlled Syntheses of Metal Oxide Nanoparticles by the Introduction of Rare-Earth Metals

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EXPERIMENTAL METHODS

Syntheses of Transition Metal Oleates. We synthesized transition metal oleate complexes following literature procedures.[1] First, 3.6 g of iron chloride hexahydrate was dissolved in 20 ml of purified water (18 MΩ) in 250 ml round bottom flask and sonicated until no visible solid mass remained in solution. Then, 12.17 g of sodium oleate, 27 ml of ethanol, and 47 ml of hexane were added to the 250 ml round bottom flask. The flask was attached to a condenser, and placed in 80 °C oil bath. After refluxing for 4 hours with vigorous stirring, the upper organic layer was washed three times with water and centrifuged at 5000 rpm for 5 minutes. After washing, hexane was evaporated off using a rotary evaporator and the product was dried in a vacuum oven. Manganese oleate was synthesized following the same procedures as iron oleate using manganese chloride tetrahydrate as starting material.[2] Metal oleates for the syntheses of manganese ferrite were prepared from manganese chloride, iron chloride, and sodium oleate following a literature procedure.[3]

Synthesis of Rare-earth Metal Oleate. To synthesize gadolinium oleate, 3.0 g of gadolinium chloride hydrate was dissolved in 13 ml of water in 250 ml round bottom flask with sonication. Then, 7.6 g of sodium oleate, 17 ml of ethanol, and 30 ml of hexane were added to the 250 ml round bottom flask. The remaining synthetic and washing procedures for gadolinium oleate were similar to those used for iron oleate. Yellowish transparent compound was obtained after rotary evaporation, which was stored in a vial in a vacuum oven. Europium oleate and cerium oleate were synthesized using the same method as gadolinium oleate.

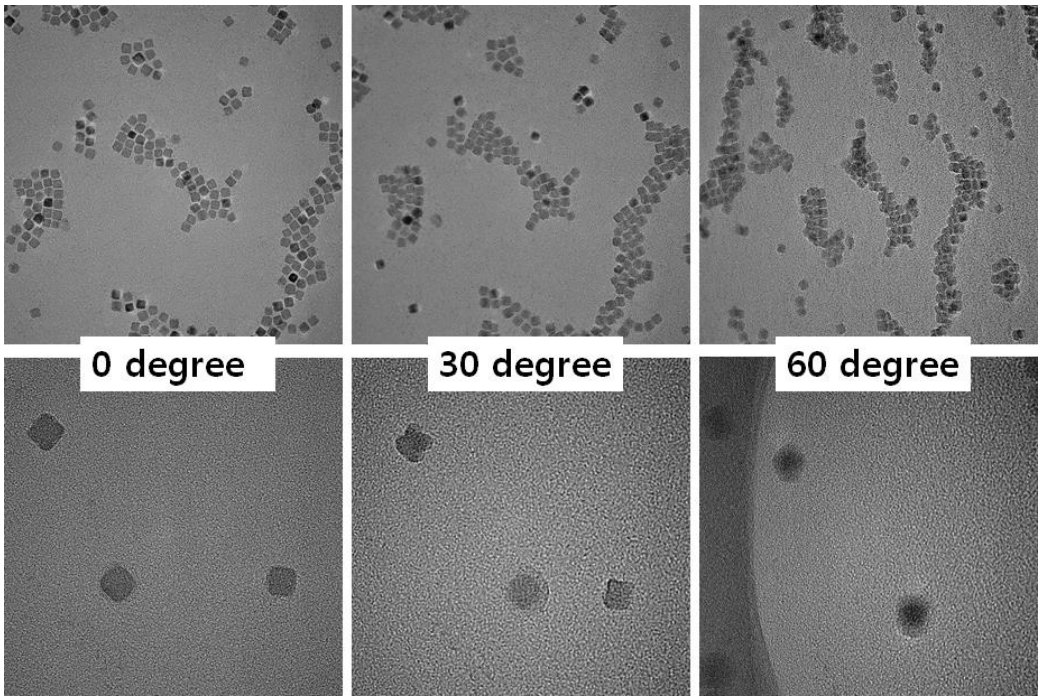

Fig S1. TEM images of Gd-coated iron oxide nanoparticles (15 wt% Gd) at different tilt angles.

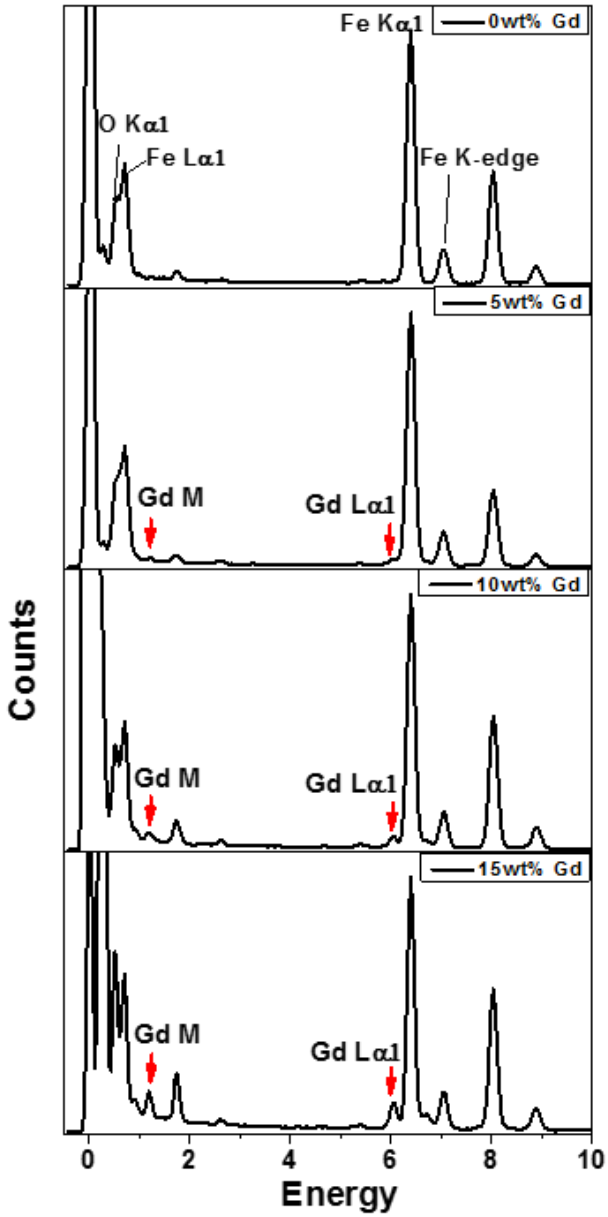

Fig S2. Energy dispersive X-ray spectroscopy (EDS) of Gd-incorporated iron oxide nanoparticles.

The measurements were carried out with FeO-rich particles with minor phases of Fe_3O_4/Fe_2O_3.

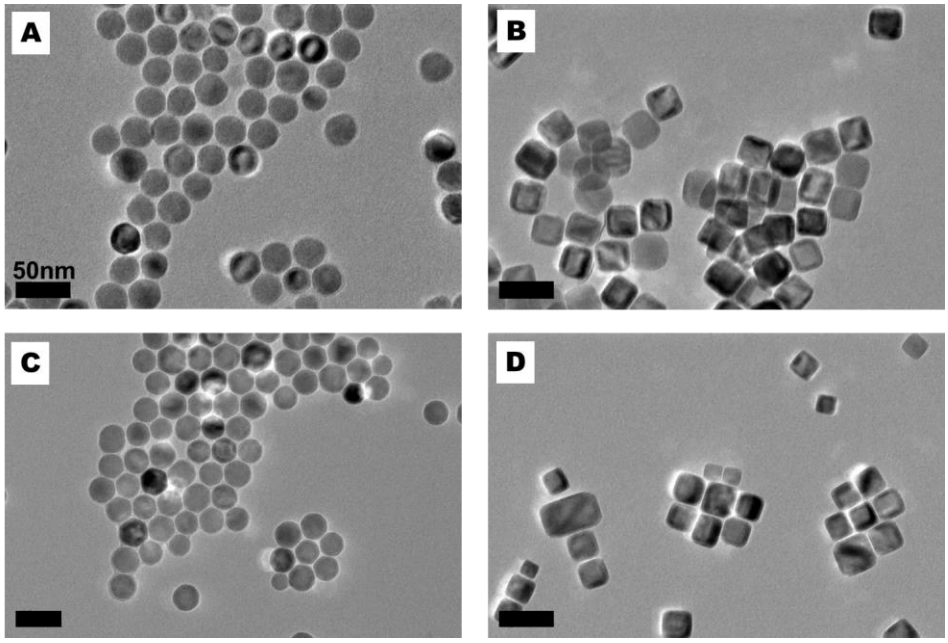

Fig S3. TEM images of nanoparticles synthesized using docosane (A-B) or trioctylamine (C-D) as the solvent. Particles presented in A and C were synthesized without gadolinium oleate. Particles presented in B and D were synthesized with 5 wt% and 15 wt% gadolinium oleate, respectively. The scale bar is 50 nm.

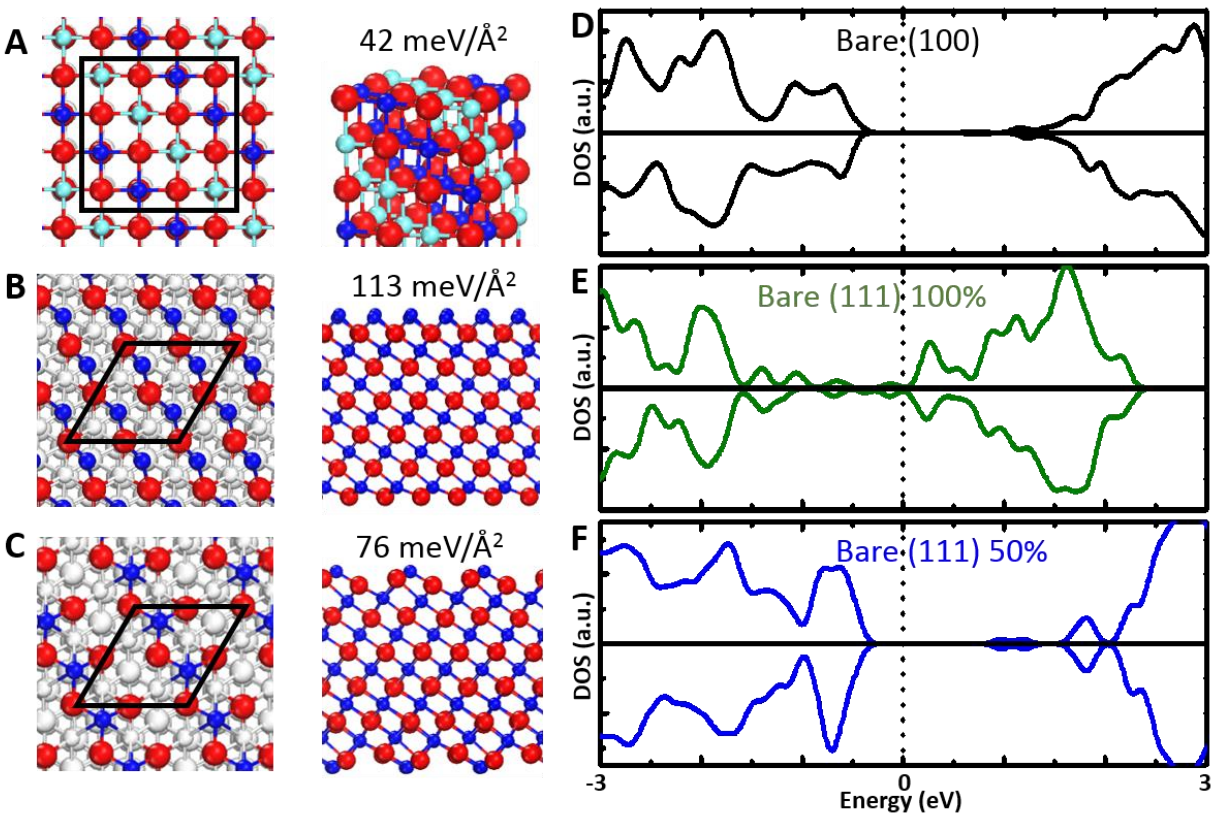

Fig S4. Top and side views of (A) bare (100), (B) bare (111), and (C) half-coverage (111) slab models and (D-F) respective electronic structures. The up and down magnetic ordering is represented as blue and light blue balls in (A). The units of surface slab models are expressed with black solid lines in first column. The surface energy is also displayed on top of atomic structure.

References

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3. N. Bao, L. Shen, Y. Wang, P. Padhan and A. Gupta, *J. Am. Chem. Soc.*, 2007, **129**, 12374-12375.