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Facile Synthesis and Magnetic Phase Transformation of Nd-Fe-B Nanoclusters by Oxygen Bridging

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1. Analysis of the surface charge of the Fe-B particles by using a zeta potential analyzer

In order to analyze the surface charge on the Fe-B nanoparticles, the Fe-B nanoparticles and Nd-Fe-B nanoclusters were synthesized in aqueous borohydride solution. The as-synthesized Fe-B nanoparticles and the as-synthesized Nd-Fe-B nanoclusters were then immersed in cyclohexane as a solvent in order to prevent surface reactions, such as oxidation. The surface charge on both types of nanoparticle was then measured by a zeta potential analyzer ver. 2.18 (Brookhaven Instruments Corp). Figure S1 show that the mean zeta potential values of Fe-B and Nd-Fe-B nanoparticles were measured as -39.73 mV and 43.95 mV, respectively. This result indicates that the electrostatic interaction between Nd cations and the negatively charged Fe-B surface helps to reduce the Nd^{3+} even with its high reduction potential.

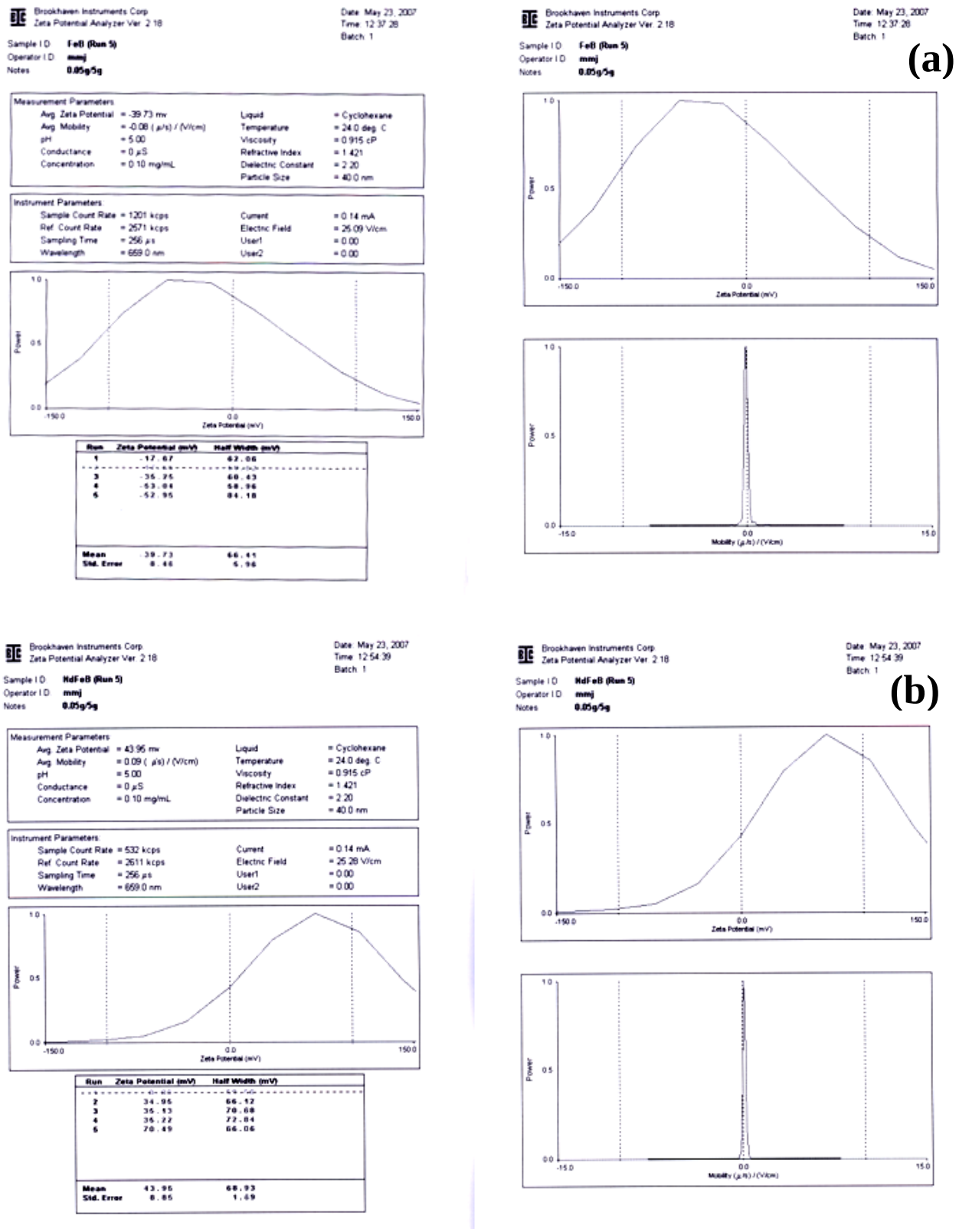

Figure S1. Surface charge analysis of as-synthesized (a) Fe-B, and (b) Nd-Fe-B nanoclusters using a zeta potential analyzer.

2. TEM micrographs of Fe-B nanoparticle and Nd-Fe-B nanocluster

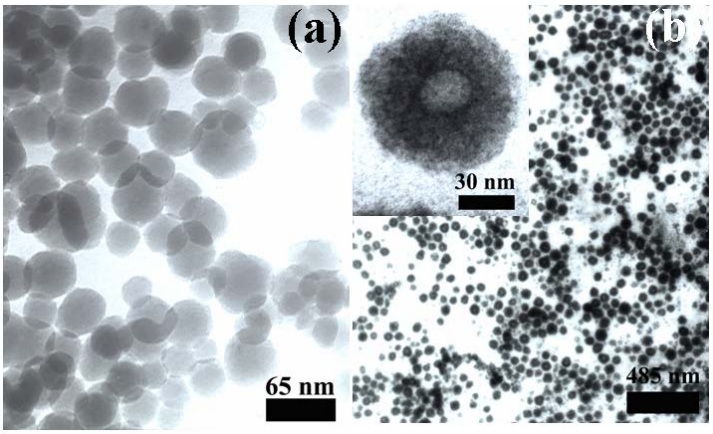

Figure S2. TEM micrographs of (a) Fe-B nanoparticles and (b) Nd-Fe-B nanoclusters under the same conditions.

Compared with the TEM micrograph Figure S2(a) of Fe-B nanoparticles, for example, for Nd-Fe-B nanoclusters, Figure S2(b) shows that the individual nanosphere is composed of smaller nanoparticles. The presence of a Ln element can make the different morphology of both phases from the results identified with various analyzer. After being dispersed with ultra-sonic agitation, the individual nanosphere is composed of aggregate-like particle with diameter of 2 nm Figure S2(b). Figures S2 and S3 demonstrate that the Fe-B and Nd-Fe-B phases proceed through the separated nucleation and growth of nanoparticles in this system. Note the discrete structure of Nd-Fe-B nanoclusters compared with that of Fe-B nanophase.

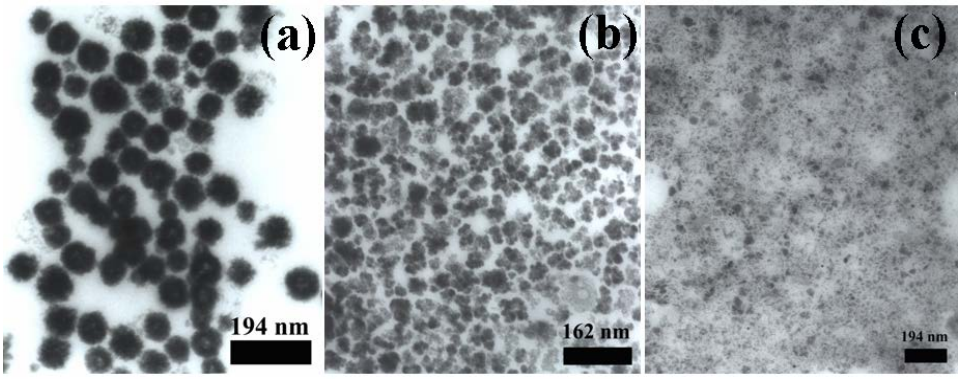

Figure S3. TEM micrographs of (a) as-synthesized Nd-Fe-B nanoclusters, (b) the products after dispersion with ultra-sonic agitation for 10 min, and (c) after agitation 20 min.