Iron oxide nanomaterials synthesized by laser ablation in liquids and their phase transition induced by laser irradiation

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The newly emerged technique of laser ablation in liquids (LAL) [1] has proven to be valid for synthesis of a large variety of colloids resulting from material removal of the substances. With specific targets, simply changing the liquids for LAL allows easy alteration of the colloidal properties such as sizes and phases. For synthesis of magnetic particles by LAL, the most frequently investigated material is Fe, whose results have turned out to be in great diversity depending on experimental conditions. Fe@α-Fe2O3 and α-Fe2O3 single-crystalline particles are synthesized by femtosecond laser ablation of Fe in water [2], which possess the minimum blocking temperature of 52 K among all the iron oxide particles synthesized by LAL. The significant decrease in the blocking temperature benefits from the generation of a large amount of ultrasmall α-Fe2O3 particles less than 10 nm. The saturation magnetizations (Ms), remanence (Mr) and coercivities (Hc) values for as-prepared magnetic nanoblends are 72.5 emu/g, 6.8 emu/g, and 160 Oe at 5K and 61.9 emu/g, 3.4 emu/g, and 70 Oe at 300 K, respectively. In comparison, the blocking temperature (ca. 230 K) of Fe@FeOx coreshell particles obtained by laser ablation in water was much higher due to larger sizes of the particles. Nevertheless, they possess higher magnetic properties with Ms, Mr, Hc of 110 emu/g, 28 emu/g and 435 Oe, respectively. Finally, phase transition of Fe@FeOx coreshell particles obtained by laser ablation in water by laser irradiation in air was investigated [3].

Reference

[1] Zhang, D., Gökce, B. and Barcikowski, S. Laser synthesis and processing of colloids: Fundamentals and applications. Chem. Rev. 117, 3990-4103 (2017).

[2] Zhang, D., Choi, Wonsuk., et al. Fe@FeOx, Fe@C and Ultrasmall α-Fe2O3 Single-Crystal Nanoblends with Low Blocking Temperature Synthesized by Sub-Picosecond Laser Ablation of Fe in Acetone. Nanomaterials, Nanomaterials. 8, 631 (2018).

[3] In preparation.