SYNTHESIS AND MAGNETIC PROPERTIES OF MANGANESE-IRON SPINEL NANOCRYSTALS

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Manganese-iron oxide $Mn_{3-x}Fe_xO_4$ (x=1.25, 1.50, 1.75) nanocrystals were prepared through polyol reduction of manganese chloride tetrahydrate ($MnCl_2{\cdot}4H_2O$) and ferric chloride hexahydrate ($FeCl_3{\cdot}6H_2O$) in the presence of oleic acid, oleylamine, and sodium hydroxide (NaOH). The as-synthesized nanocrystals have the cubic spinel structure and mean crystallite size of 4.8-5.3 nm. Their monodispersities were characterized by dynamic light scattering (DLS) and transmission electron microscopy (TEM). Magnetic measurements show that the as-synthesized magnetic nanocrystals display a superparamagnetic behavior with zero coercivity and remanence. The saturation magnetization of $Mn_{3-x}Fe_xO_4$ obtained by the plots of M against $1/H$ curve were 1.8, 5.1, and 6.8 emu/g for x = 1.25, 1.50, and 1.75, respectively. Thermal annealing induces the change of crystallite size and thus the magnetic properties of the nanocrystal assembled films. Both microstructure and magnetic behavior of the nanocrystal assembled films are very sensitive to the film composition. In general, the coercivity of film first increases as the crystallite size increases reaches a maximum and then decreases for any further increase in crystallite size. Very high coercivity (3200 Oe) was observed for composition with $Mn_{1.75}Fe_{1.25}O_4$. Magnetic interaction between nanocrystals of these self-assembled nanocrystal films was analyzed by examining the remanent magnetization curves via the Henkel-plots and δM-plots [1, 2]. This controlled synthesis and assembly can be used to fabricate $Mn_{3-x}Fe_xO_4$ nanocrystal films for future nanomagnetic applications in various technological fields, such as ferrofluids, sensing elements, and recording media..

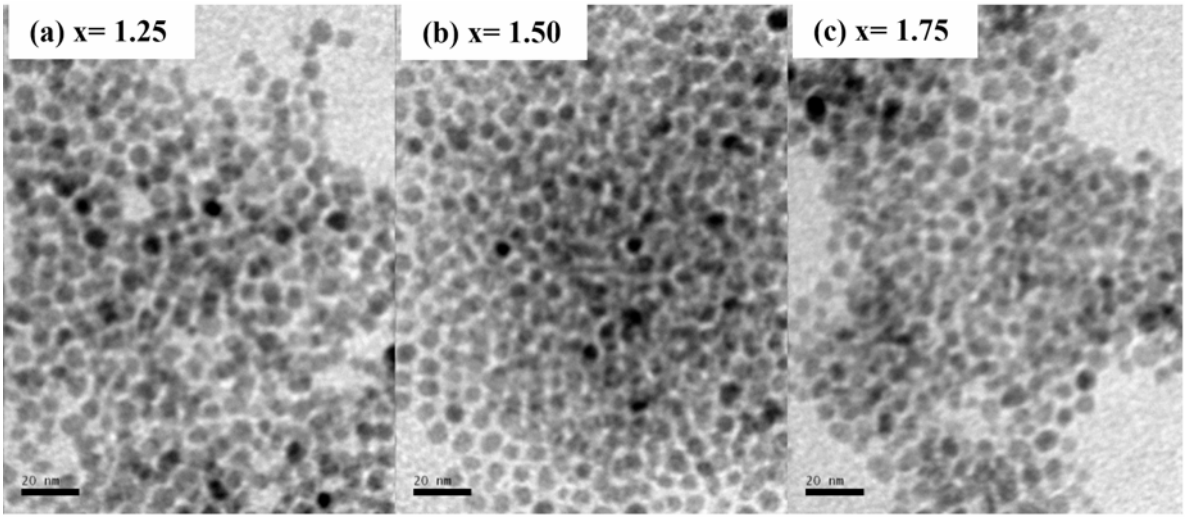

Fig. 1. TEM micrograph of $Mn_{3-x}Fe_xO_4$ nanocrystals.

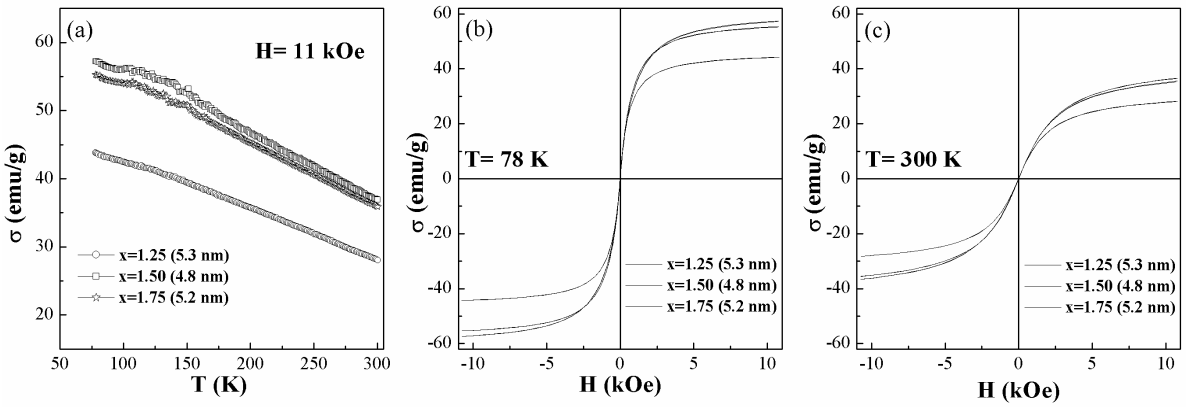

Fig. 2. (a)Temperature dependence of the ZFC and FC magnetization, and hysteresis loops measured at (b) 78 K and (c) 300 K for $Mn_{3-x}Fe_xO_4$ nanocrystals with different composition.

REFERENCES

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[2] P. E. Kelly, K. O'Grady, P. I. Mayo, and R. W. Chantrell, IEEE Trans. Magn. 25, 3881 (1989).