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Characterization on Fe_3O_4 Nanoparticles by Mössbauer Studies

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Here we report a preparation of iron oxide nanoparticles and correct characterizations by Mössbauer spectroscopy and transmission electron microscope (TEM). Mössbauer studies are essential tool because the only x-ray diffractometer (XRD) patterns in nanoparticles could not distinguish iron oxides from magnetite, maghemite, and spinel oxides because of similar crystal structure.

Magnetite (Fe_3O_4) with spinel structure are made by reaction of iron(III) acetylacetonate [$Fe(acac)_3$] with surfactants at high temperature. We have used the phenyl ether, benzyl ether, and 1, 2-hexadecanediol as solvents [1]. $Fe(acac)_3$ was mixed in phenyl ether and benzyl ether for synthesis of the magnetite (Fe_3O_4). As boiling point of phenyl ether (259 ℃) is lower than that of benzyl ether (298 ℃), the size of magnetite nanoparticles can be controlled.

The average particle sizes of magnetite were 4 and 6 nm, narrow size distribution was convinced by HRTEM. The crystal structure was characterized by XRD patterns, but the magnetite and maghemite phase were distinguished easily. We could carry out the measurement of Mössbauer spectrum at room temperature and 4.2 K. Our iron oxide nanoparticles show superparamagnetic behavior at room temperature. At 4.2 K, Mössbauer spectra were shown the typical spectrum patterns of the magnetite [2]. The analysis parameters, for the 6 nm iron oxide nanoparticles sample, are a general sextet shape indicating ferrimagnetic behaviors. For this sample, the 4.2 K spectrum was fitted using two magnetic components of hyperfine fields H_{hf} = 51.4 and 49.2 T, isomer shifts δ = 0.35 and 0.73 mm/s corresponding to Fe^{3+} ions at site *A* and Fe^{2+} ions at site B, respectively.

The saturation magnetization M_S were 59.5 *emu/g* for 4 nm and 59.7 *emu/g* for 6 nm at room temperature (295 K) under an applied field of 10 kOe.

These samples will be used to candidate for biomedicine applications as magnetic carriers [3].

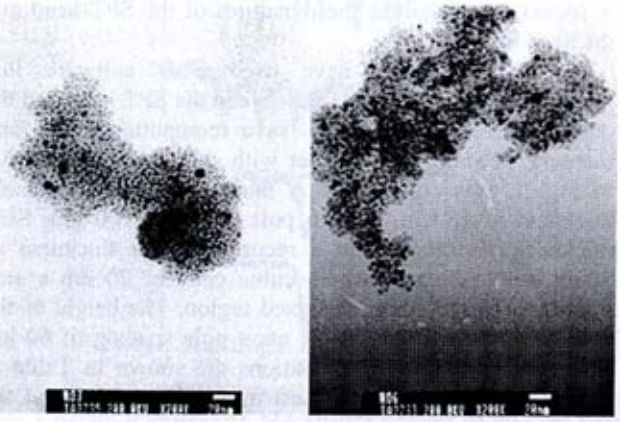

Fig. 1. TEM images of 4 nm (left image) and 6 nm (right image) iron oxide nanoparticles. It is considered that the phase were magnetite phases.

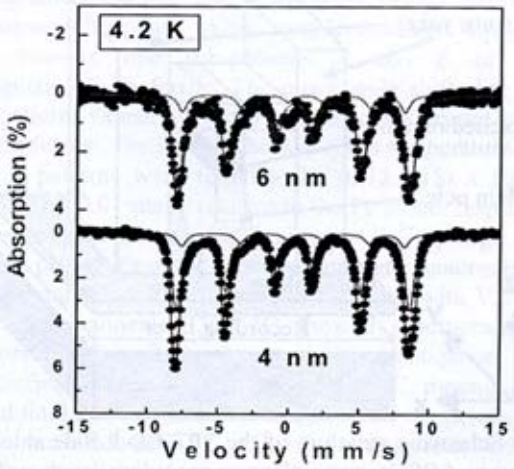

Fig. 2. Mössbauer spectra of 4 nm and 6 nm nanoparticles at 4.2 K.

References

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