

実験報告書様式(一般利用課題・成果公開利用)

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	承認日 Date of Approval 2013/11/23 承認者 Approver Jun-ichi SUZUKI 提出日 Date of Report 2013/05/28
課題番号 Project No. 2012B0255 実験課題名 Title of experiment Wide angle neutron scattering study on magnetic anisotropy of magnetite nanoparticles 実験責任者名 Name of principal investigator Hiroaki MAMIYA 所属 Affiliation National Institute for Materials Science	装置責任者 Name of Instrument scientist Suzuki Jun-ichi PhD 装置名 Name of Instrument/(BL No.) TAIKAN/BL-15 実施日 Date of Experiment 6th March to 8th

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
 Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.
Magnetite nanoparticles dispersed in deuterated toluene $\text{Fe}_3\text{O}_4/\text{C}_{18}\text{H}_{34}\text{O}_2/\text{C}_6\text{D}_5\text{CD}_3$ Cobalt ferrite nanoparticles dispersed in deuterated toluene $\text{CoFe}_2\text{O}_4/\text{C}_{18}\text{H}_{34}\text{O}_2/\text{C}_6\text{D}_5\text{CD}_3$ Liquid (1 mL) each

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。) Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.
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Experimental

We prepared magnetite and cobalt ferrite nanoparticles (see Fig. 1) and dispersed in a solvent of deuterated toluene. Then we enclosed them in sealed containers (see Fig. 2.) Small angle neutron scattering profiles of these samples were observed in a zero magnetic field and in several magnetic fields in the range to 10 kOe. The experiments were performed at room temperature.

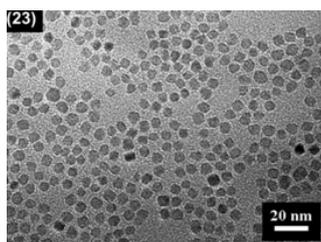


Fig. 1. TEM of the magnetite nanoparticles



Fig. 2. Sample enclosed in a sealed container.

Results

Figure 3 shows the obtained small angle neutron scattering (SANS) profiles for a typical magnetite nanoparticles (mean diameter $d = 6.6$ nm) dispersed in deuterated toluene, while Fig. 4 exhibits SANS profiles for a typical cobalt ferrite nanoparticles ($d = 9.2$ nm) dispersed in deuterated toluene.

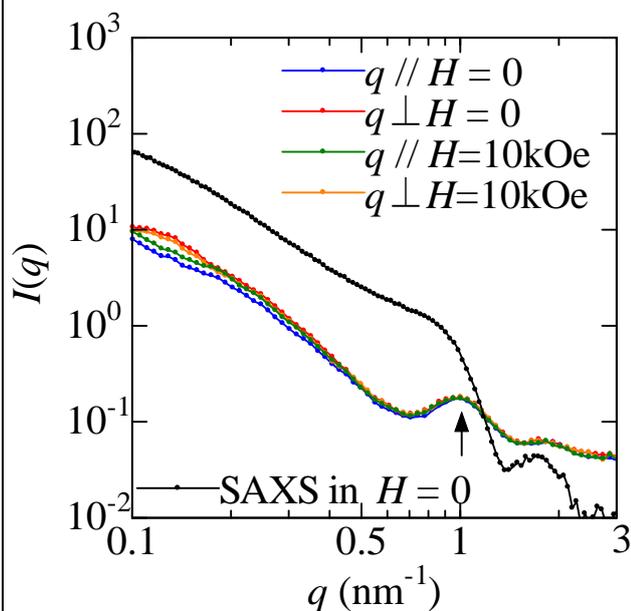


Fig. 3. Small angle neutron scattering profiles for a typical magnetite nanoparticles. For comparison, SAXS profile of the same sample is plotted.

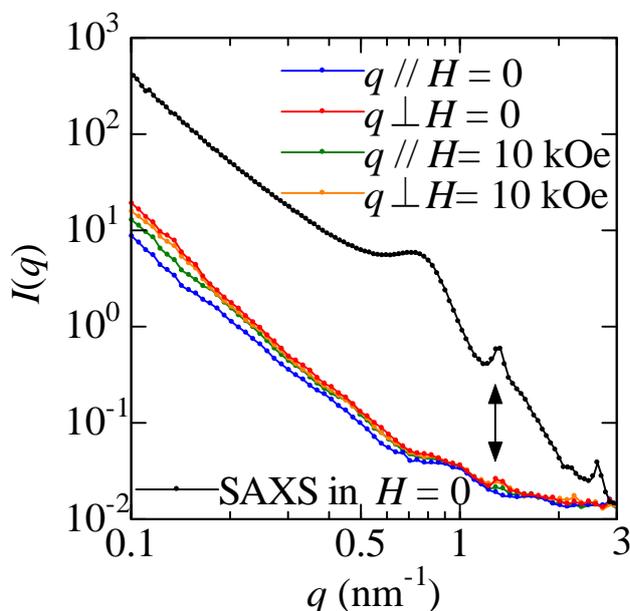


Fig. 4. Small angle scattering profiles for a typical cobalt ferrite nanoparticles. For comparison, SAXS profile of the powder of the same nanoparticles is plotted.

It is easily found that, in contrast to small angle X-ray scattering (SAXS) profile, there is a peak at a scattering vector q of 1 nm^{-1} in the SANS profile of the magnetite nanoparticles, as indicated by the arrow in Fig. 3. This peak can be attributed to the interference within the shell layer of oleic acid with light hydrogen atoms, because the scattering length density of the shell layer is much different not only from that of the solvent $\text{C}_6\text{D}_5\text{CD}_3$ but also from the core of Fe_3O_4 . In addition, magnetic-field-induced variations of the SANS profile are found in the low q range. This result suggest that magnetic correlation exists between the nanoparticles.

For the cobalt ferrite nanoparticles, a broad peak observed at q of 0.7 nm^{-1} in SAXS profile of the powder state disappears in the SANS profiles of a liquid state (see Fig. 4). Therefore, this peak can be attributed to the inter-particle interference. On the other hand, novel sharp peaks observed at q of 1.2 nm^{-1} in SAXS profile remain in the SANS profiles, as indicated by the arrow in Fig. 4. Furthermore, it seems to depend on the magnetic field. For these reasons, it can be considered that the sharp peak comes not from simple super-lattice structure of surfactant molecules but from more complicated origin.