Experimental report

21/09/2019

Proposal: 5-42-480 **Council:** 4/2018

Title: Dynamical SANSPOL study on field-induced assembly of iron oxide nanoparticles

Research area: Physics

This proposal is a new proposal

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Samples: iron oxide ferrofluid

Instrument	Requested days	Allocated days	From	To
D22	3	0		
D33	0	2	22/10/2018	24/10/2018

Abstract:

SANS studies have shown that in iron oxide ferrofluid an unusual ordering phenomenon of the magnetic nanoparticles occurred when static magnetic field was applied. The structure of the self-assembly has been found to be FCC, different from what were reported for magnetite and Co ferrofluids. The field-induced ordering process is found irreversible. The crystalline quality is improved upon field oscillation. Surprisingly, the diffraction peak intensity shows a significant increase at fields around zero. By using time-resolved SANSPOL technique on D22, we intend to study the dynamical processes of the field-induced assembly in magnetic colloids and give more insight into the effect of the inter-particle magnetic correlations on the formation of local nanoparticle ordering.

Experimental report: Dynamical SANSPOL study on field-induced assembly of iron oxide nanoparticles (Exp. No. 5-42-480)

The experiment was carried out on D33 because the choppers of D22 were being repaired. We performed time-resolved SANSPOL measurement on iron oxide nanoparticles. We installed the oscillating magnetic field generator at the sample position of D33. The field direction was aligned to be perpendicular to the incident neutron beam. The oscillating magnetic field had periodic sine-wave modulations with amplitudes from 3 mT to 27 mT. The frequency range was between 1 and 300 Hz. The set-up of the magnetic field was synchronized with the kinetic mode of the SANS measurements by a trigger signal sent from the frequency generator. The SANS intensities in both non-spin-flip $\boldsymbol{I}_{NSF}$ and spin-flip $\boldsymbol{I}_{SF}$ channels were recorded.

As shown in Fig. 1, the $\boldsymbol{I}_{NSF}$ and $\boldsymbol{I}_{SF}$ measured at 50 and 100 Hz are plotted as a function of frame time. From qualitative analysis of data, we can tell that the magnetic nanoparticles form large aggregates even under small oscillating fields. Further quantitative analysis will be carried out to give a deeper understanding to the assembling phenomenon of iron oxide nanoparticles in oscillating magnetic fields.

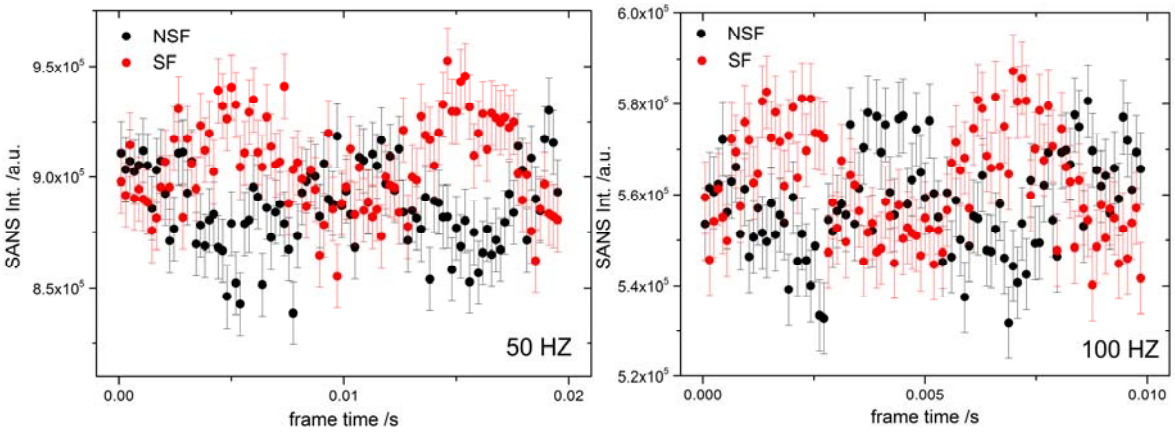

Fig. 1. the spin-flip and non-spin-flip SANS intensities are measured at 50 and 100 Hz, and plotted as a function of frame time.