Experimental report

29/06/2022

Proposal: **5-53-300**

Council: 10/2020

Title: Magnetization Distribution and Spin Disorder in Magnetic Nanoassemblies

Research area: Chemistry

This proposal is a new proposal

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Samples: iron oxide nanoparticles
iron oxide nanoassemblies

Instrument	Requested days	Allocated days	From	To
D33	4	3	14/06/2021	17/06/2021

Abstract:

The objective of this proposal is to investigate (using SANSPOL) the magnetization distribution in magnetic multi-core nanoassemblies on both the length scale of the individual nanoparticles and the spherical nanoparticle assemblies. Our findings will be correlated with macroscopic magnetization measurements and magnetic hyperthermia performance.
As a result, we expect to disentangle the effect of interparticle interactions and oriented arrangement on both the magnetization distribution and spin disorder within the individual nanoparticles and the spatial homogeneity of the magnetization in the nanoassemblies. We finally aim to elucidate a potential correlation between spin disorder and magnetic hyperthermia performance.

Experimental Report: Magnetization Distribution and Spin Disorder in Magnetic Nanoassemblies

The aim of this experiment was to investigate (using SANSPOL) the magnetization distribution in magnetic multi-core nanoassemblies on both the length scale of the individual nanoparticles and the spherical nanoparticle assemblies.
As a result, we planned to disentangle the effect of interparticle interactions and oriented arrangement on both the magnetization distribution and spin disorder within the individual nanoparticles and the spatial homogeneity of the magnetization in the nanoassemblies, with the aim to elucidate a potential correlation between spin disorder and magnetic hyperthermia performance.
A series of samples were investigated using SANSPOL at the D33 instrument at two detector distances (5.3 and 10.3 m) and in a magnetic field of 0.7 T. Fig. 1 shows SANS and SANSPOL measurements of sample MaC284h (spherical nanoassemblies, d = 78.2 nm).

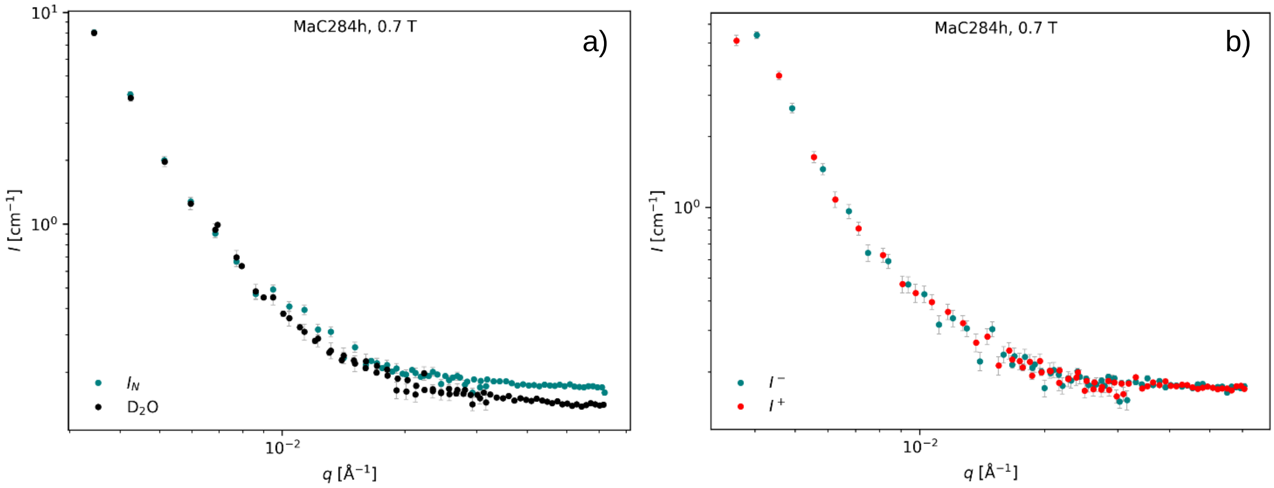

Fig.1: a) SANS measurement of MaC284h and D_2O at 0.7 T, b) SANSPOL measurements of MaC284h at 0.7 T.

Unfortunately, all nanoassembly dispersions could only be obtained in very low concentrations, so that a significant structural or magnetic scattering response beyond the D_2O reference was not evident (Fig. 1).

To use the rest of the beamtime as efficiently as possible, backup samples consisting of spherical ferrite nanoparticles of varying particle sizes were measured.
The polarized SANS cross sections of two samples with particle sizes of 9 nm and 12 nm were measured at 9 different fields from 0.02 – 0.82 T and are shown in Fig. 2.

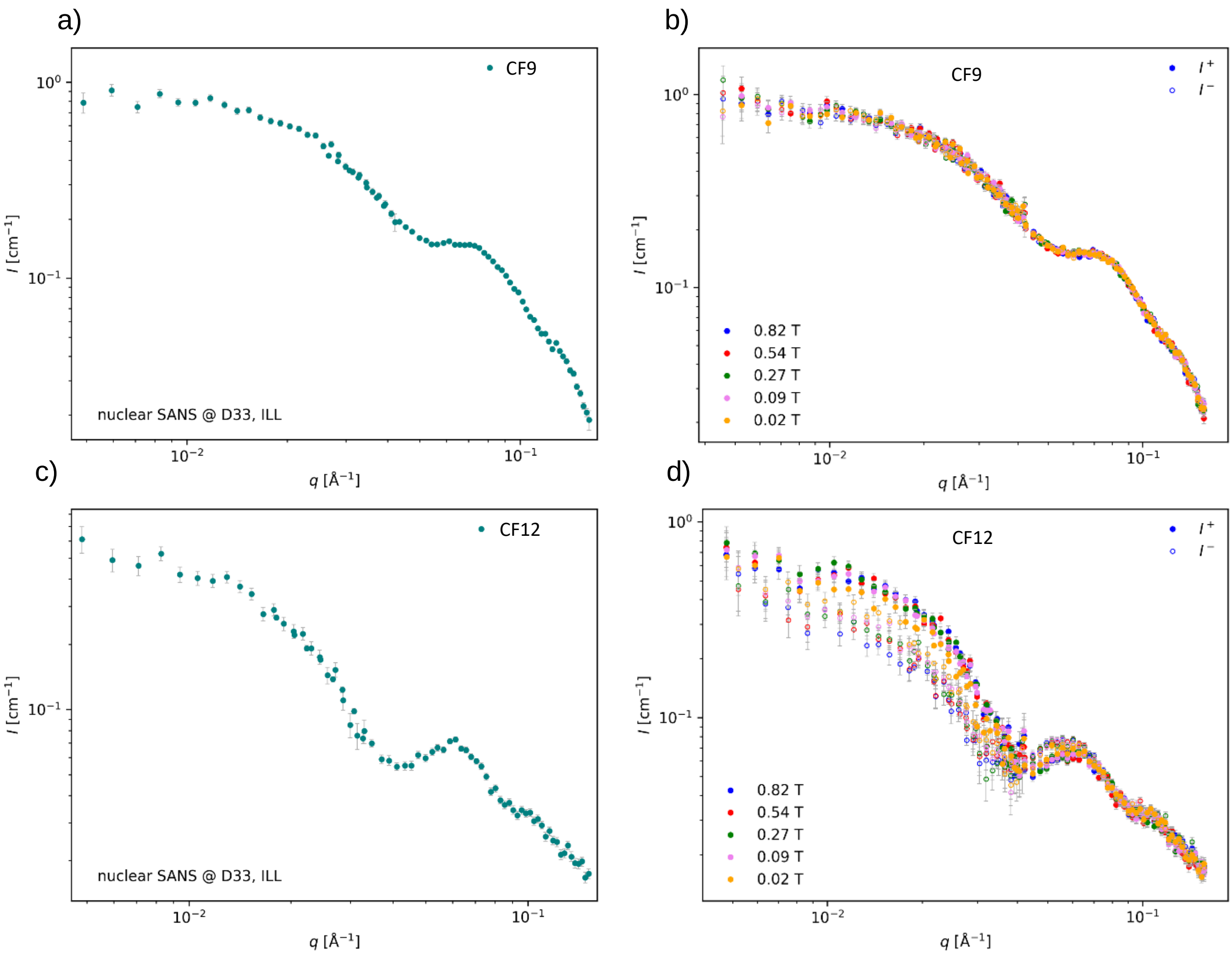

Fig. 2: a-b) SANS and SANSPOL of CF9. c-d) SANS and SANSPOL of CF12.

We clearly observe the form factor minima in the nuclear SANS cross section, as well as a separation of I^+ and I^- in the magnetic contrast. The larger magnetic contrast of the larger nanoparticles indicates a higher magnetic scattering length density, corresponding to a significantly enhanced magnetization, in agreement with our macroscopic precharacterization. The data will be analyzed within the particle-matrix framework to give more detailed insight into the chemical morphology and magnetization profile of the nanoparticles.