Contribution ID: **15** Type: **Short talk**

Characterising self-assembly of magnetic nanoparticles

Wednesday 26 June 2019 10:00 (20 minutes)

Self-assembly is the phenomenon of spontaneous organization of nanoparticles into a stable 1D, 2D or 3D assemblies on a substrate or in solution. Understanding the origin of self-assembly will allow us to harness unique properties of the material that are both multifunctional and adaptable with applications in various fields of biomedical engineering and material science. Self-assembly of magnetic nanoparticles (MNPs) in solutions depends on parameters like the particle size, external magnetic field, the thickness of surfactant, concentration and synthesis routines. Here, we aim to understand the mechanism that governs self-assembly by tuning the size, field, and concentration of NP's in solution.

Superparamagnetic iron oxide nanoparticles (NPs) of 20nm and 27nm were characterized using Transmission Electron microscopy (TEM) to determine the size and size distribution. The 2-D pattern obtained from Small Angle X-ray Scattering (SAXS) and Small Angle Neutron Scattering (SANS) of 20nm NPs is isotropic up to high concentrations (1%vol) and maximum fields (2.2 T) indicative of no self-assembly. On the other hand, the 27nm NPs revealed anisotropy in the 2-D pattern for even low concentrations (0.42%) and low fields (0.004T) indicative of an order in the system. A linear pearl model best describes the radially averaged SANS and SAXS data of 27nm NPs, indicating the presence of chains even at zero field. The weakly interacting 20nm NPs are further understood using half-polarized neutron scattering (SANSPol) which allowed us to separate the magnetic form factor from dominating nuclear one. The difference signal exhibits a sin^2 behavior which yields the nuclear and magnetic interference term for dispersed non-interacting 20nm NPs. SANSPol measurements on 27nm are similar to their SANS pattern, which is further analyzed using sector analysis to obtain the form and structural factors. Moreover, such analysis will allow us to estimate the role of dipolar interactions. Macroscopic magnetization measurements revealed a different magnetic behavior in dilute and concentrated samples indicating the influence of interactions in both NPs. We obtained a crystal structure of two NPs in order to gain more insights into the possible origin of this profound size effect on self-assembly. We used x-ray PDF (Pair distribution function) to determine composition and lattice constants, as well as to separate between various forms of iron oxides often present in NPs of our size.

Authors: NANDAKUMARAN, Nileena; FEYGENSON, Mikhail (JCNS/FZ-Juelich); BARNSLEY, Lester (Jülich Centre for Neutron Science); FEOKTYSTOV, Artem; BRÜCKEL, Thomas (Forschungszentrum Jülich GmbH)

Presenter: NANDAKUMARAN, Nileena

Session Classification: Science group meetings 1