

## SANS STUDY OF TIME DEPENDENT ORDERING PROCESSES IN CONCENTRATED FERROFLUIDS INDUCED BY EXTERNAL MAGNETIC FIELDS

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We are currently performing a comprehensive study of the microstructure of magnetic liquids by Small Angle Scattering including polarised neutrons (SANS-POL) and Synchrotron X-rays (SAXS) <sup>1</sup>. In Cobalt ferrofluids nanosized magnetic particles are protected from coagulation by a shell of nonmagnetic surfactants. In concentrated samples up to 6 vol.% Co the combination of these techniques allowed the magnetic and nuclear form-factors to be reliably separated from the structure factors [1,2]. In samples with Co concentrations above 1 vol.% well defined peaks have been observed in the 2D SANS pattern in an external magnetic field. Interparticle interactions are induced by an external magnetic field that gives rise to pseudo-crystalline ordering. The Cobalt core-shell particles are arranged in hexagonal planes, with the magnetic moments aligned parallel to the [110] direction. Two types of equivalent textures were found to be present simultaneously, corresponding to a stacking of the hexagonal planes in horizontal and vertical direction. In addition, segments of uncorrelated chains of particles with parallel moments are aligned along the magnetic field and frozen-in when the carrier liquid is solidified. While spontaneous formation of chain-like particle arrangements have been predicted by de Gennes [3] and confirmed [4] field-induced lamellar hexagonal particle arrangement have never been observed so far experimentally in colloidal magnetic liquids. Beside magnetic dipolar interactions between the particles additional attractive interaction could stabilize different types of ordering. Molecular dynamic studies [5] gave evidence of various intermediate structures. The presumed attractive interaction could be mediated by the nonmagnetic surfactants and micelles leading to very slow relaxation processes.

Here we report on time-resolved SANS investigations which aimed to follow the dynamics of the ordering and disordering processes. For this purpose the ferrofluid samples were placed in a homogenous magnetic field perpendicular to the incoming neutrons which allows the in-plane peaks to be observed. Then SANS patterns have been measured in very short time slices between 50 ms up to few seconds, triggered by a signal from the magnetic field, when the set point of the magnetic field is reached. By this stroboscopic technique the time dependence of the ordering and disordering process has been studied under various conditions. The analysis of the 2D pattern showed i) the reversibility of the process, ii) the overall dynamics, and iii) the nature different types of ordered domains.

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