Effect of magnetic fields on dynamics of interacting magnetic nano particles

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Dynamic Light Scattering (DLS) and Depolarized Dynamic Light Scattering (DDLS) are employed to study the dynamic behavior of suspended magnetic cobalt nanoparticles. The particles are stabilized by a combination of steric and electrostatic effects. When charges are absent, chain-forming occurs due to magnetic dipole-dipole interactions. By adding tri-n-octylphosphine oxide (TOPO) to the synthesis mixture, a surface charge is created, and the electrostatic repulsion overcomes the magnetic dipole attraction and Van der Waals forces. The diffusivity of two systems that differ by the presence or absence of TOPO is described. From DLS measurements we obtained the diffusion coefficient for various concentrations of both samples. From the change of the diffusion coefficient with concentration the particle-particle interactions are characterized. The rotational diffusion coefficient of chain structures is measured by means of DDLS. The length of the chains can be deduced from the value of the rotational diffusion coefficient. The dynamics of these two systems have been compared at zero external field and when subjected to a static magnetic field of 3.7 mT. Under the influence of the external magnetic field the diffusion coefficient of both systems decreases. This decrease is most likely due to chain formation in the system under the external magnetic field. From the time-dependent decrease of the diffusion coefficient the chain formation constant is evaluated. The slowing down of diffusion under the influence of the magnetic field for the sample without TOPO can be explained by cluster formation, a generally expected description for chain structures under the influence of a static external magnetic field.