Hematite Ellipsoids coated with Silica Shell: Phase Behavior and Dynamics

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Colloidal particles showing anisotropy have been commonly observed either in synthetic (coatings, construction materials, oil drilling, etc.) or natural (cells, clays, cellulose, etc.) materials. Such systems display a diverse phase behavior depending on concentration, aspect ratio, and/or presence of external fields (e.g. electromagnetic fields) that can tune the single particle properties and the interparticle interactions. As an example, for simple thin hard rods, the system may undergo a transition from an isotropic to a nematic state when the volume fraction is high enough. For ellipsoidal particles with a smaller axial ratio, additional states are expected such as a stretched FCC crystal as well as a glassy state at very high densities. Moreover, anisotropic systems also exhibit more complex dynamics, with a possibility to observe the different contributions of rotational and translational diffusion, a decoupling of diffusion coefficients in different directions, and a more complex transition to different arrested states. Such kind of information can be obtained by using, for instance, differential dynamic microscopy (DDM), which is based on temporal fluctuations of the intensity in optical microscopy.[1]

Here we use dispersions of ellipsoidal particles composed of a hematite core and a silica shell as a convenient model of an anisotropic colloidal system, utilizing features such as an easily tunable aspect ratio which allows to reach a wide region in the phase diagram, and the response to magnetic fields (due to the ferromagnetic core) which that provides control of the rotational degree of freedom.[2] We describe their structural and dynamic properties from dilute conditions up to the glass transition, while exploiting their ability to orient in a homogeneous external magnetic field. We use DDM to determine the concentration dependence of the diffusion coefficient and its decoupling along parallel and perpendicular directions with respect to the field, and follow the onset of arrest as the system undergoes a glass transition.

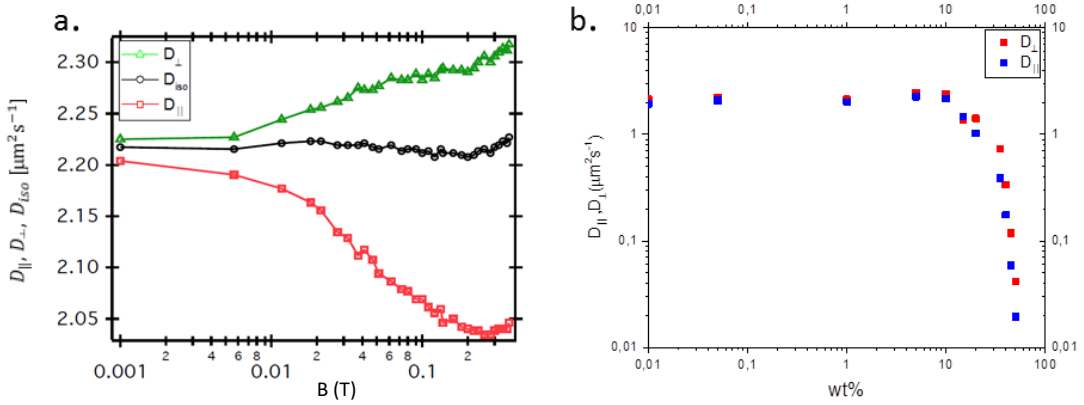

Figure 1 a) Decoupling of the diffusion coefficient along parallel and perpendicular directions with respect to the applied magnetic field as a function of field strength for 0.1 wt% of dispersion. **b**) Variation of the anisotropic diffusion coefficients as a function of the concentration at a magnetic field of 380 mT.

[1] M. Reufer, V. A. Martinez, P. Schurtenberger and W. C. K. Poon, *Langmuir*, 2012, **28**, 4618.
[2] M. Reufer, H. Dietsch, A. Hirt, A. Menzel and P. Schurtenberger, *J. Phys. Chem. B*, 2010, **114** , 4763.