Dynamic and rheological signatures of repulsive and attractive colloidal glasses during yielding.

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The structural changes and microscopic dynamics and their relation to the mechanical response of frustrated colloidal systems such as glasses and gels is the subject of intense ongoing research aiming in unraveling the fundamental underlying mechanisms responsible for their shear induced solid to liquid transition. Here we present some key ingredients linking microscopic and macroscopic response of repulsive (hard-sphere) and attractive glasses during nonlinear rheology and yielding deduced from a combined experimental and computer simulation study [1, 2, 3].

We mainly focus on the way such systems yield under the application of steady or oscillatory shear via start-up shear tests and large amplitude oscillatory shear, as well as on the mechanisms of structural reformation an related stress relaxation after shear cessation. We discuss the phenomenology of two-step yielding, widely observed experimentally and the underlying mechanisms and relevant length- and time-scales that cause such behavior, contrast it with findings from Brownian Dynamics (BD) simulations and discuss the role of hydrodynamic interactions (HI). Both experiments and BD simulations show two peaks in stress versus strain during start-up shear tests with good qualitative agreement suggesting that HI are not crucially important at such highly concentrated systems. Structural analysis obtained from BD simulations confirms that the first yield is related to the breaking of the structure at the length scales smaller than attraction range while the second yield point is a direct consequence of maximum anisotropy in the pair distribution function related with the cage deformation.

References:

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