Imaging of active microrheology of colloidal suspensions near the glass transition

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Glass transitions are observed in a broad range of materials. While their understanding therefore is of great relevance, many questions regarding the glass transition remain open. In this research a dense binary mixture of colloidal spheres serves as a glass forming liquid. Inspired by the work of [2, 1], we disturb the glassy state by pulling a single tracer particle with an optical tweezer through the sample. The local melting of the glass and its healing are observed with confocal fluorescence microscopy.

The bath particles are fluorescently dyed PMMA/PMMA core/shell particles, whereas the tracers are fluores- cently dyed core/shell PS/PMMA particles with a diameter of 2.0 µm. The colloids are dispersed in a refractive and density matching solvent mixture. Due to the refractive index match of PMMA with the solvent mixture, the optical tweezers can only trap the PS/PMMA tracers.

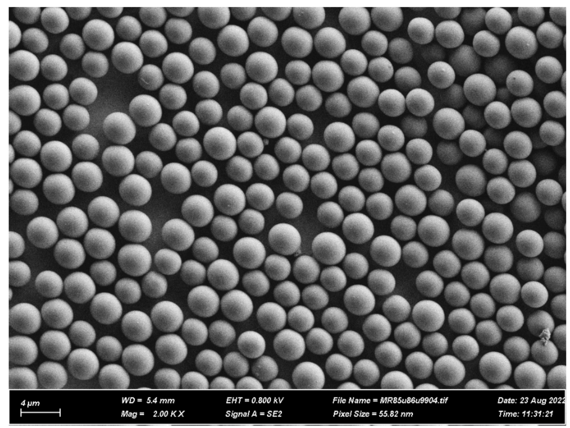

Fig. 1: *SEM image of the binary colloidal mixture of Core/Shell PMMA/PMMA particles.*

3D trajectories of all colloids in the observed vol- ume are obtained from confocal microscopy im- ages with an algorithm published in Ref. [3]. The change of the bath particle trajectories near the trac- ers gives information about the particle interaction. By measuring the evolution of the mean displace- ment (MD) of particles 9 µ m in front of the tracers, we find that the MD of particles close to the pulling axis is strongly affected by the displacement of the tracer. With increasing distance to the pulling axis, the effect on the MD rapidly vanishes. Our experi- mental results showed that after a distance of 5 par- ticle diameters to the pulling axis we cannot observe any effect. Particles close to the pulling axis move in direction of the movement of the tracer, but this movement stops after the tracer passes by.

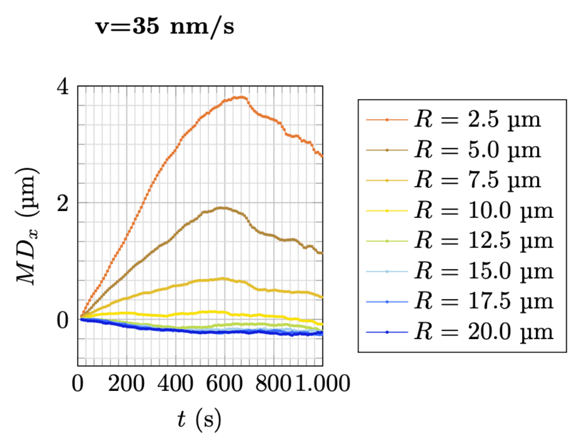

Fig. 2: *Temporal evolution of the mean displacement (MD) in x-direction (direction of pulling) for different distances R to the pulling axis. The pulling velocity is v = 35 nm/s.*

References:

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