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Glass transitions in quasi-two-dimensional suspensions of colloidal ellipsoids

YILONG HAN, Hong Kong University of Science and Technology

Colloidal glasses constitute of anisotropic particles were mainly studied by simulations in three dimensions with incomplete phase diagrams. Here we report the experiment about glass transitions in a colloidal suspension of micro-ellipsoids at the single-particle level. Video microscopy revealed a two-step glass transition corresponding to inter-domain freezing and inner-domain freezing respectively. The glass transition in the rotational degree of freedom was at a lower density than that in the translational degree of freedom. Between the two transitions, ellipsoids formed an "orientational glass" in the area fraction range $0.72 < \phi < 0.79$ for aspect ratio $p = 6$ ellipsoids and $0.60 < \phi < 0.72$ for $p = 9$. Such orientational glass is expected to be replaced by the rotator phase at small aspect ratios and the nematic phase at large aspect ratios. The observed decoupling between diffusion and relaxation for both of translational and rotational motions reflects the dynamic heterogeneity. Approaching the respective glass transitions, the rotational and translational fastest-moving particles in the supercooled liquid moved cooperatively and formed clusters with power-law size distributions. The mean cluster sizes diverge in power law as approaching the glass transitions. The translational and rotational fastest- and slowest-moving ellipsoids are all spatially anticorrelated: most translational fast-moving ellipsoids and rotational slow-moving ellipsoids formed at different areas within pseudonematic domains, while most rotational fast-moving ellipsoids and translational slow-moving ellipsoids formed at different areas around the domain boundaries.