Flow-assisted assembly of ordered colloidal structures

The assembly of colloidal crystals can be assisted by the application of external fields such as flow or sedimentation. These processes to form colloidal crystals are of technological interest because of applications in, for example, photonic band gap materials and sensors. However, for such applications, assembly ideally should yield macroscopic crystals with low defect density. Colloidal crystallization during shear deformation has been demonstrated to grow large crystallites but the way in which the flow mediates the assembly, defect density and crystal structure is not fully understood. Here we use confocal laser scanning microscopy (CLSM) to directly visualize the real-space structure of ordered arrays of colloidal spheres formed by shear flow and sedimentation. The colloids are micron-size, fluorescent monodisperse poly(methyl methacrylate) spheres dispersed in nearly refractive index matched solvents. Measures of local structure such as bond orientation parameters, vacancies and stacking faults are quantified from the confocal microscopy image volumes. To expand the kinds of ordered arrays that can be formed, we further investigate the assembly of colloidal rods by sedimentation. Stable suspensions of nearly monodisperse fluorescent poly(methyl methacrylate) ellipsoids of variable aspect ratio (major and minor axis dimension in the range 0.5-10 µm) were prepared by the adaptation of literature methods. The procedure consists of the deformation of colloidal microspheres dispersed in an elastomeric matrix that is subjected to uniaxial extensional flow. These sterically-stabilized polymeric colloids are retrieved from the matrix and stably dispersed in organic solvents. The centroid position and orientation angle of individual rod colloids are determined by quantitative image processing. We investigate the formation of phases with orientational order in dense sediments of the anisometric colloids.

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