The influence of gravity and the metastable state in colloidal phase transition

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Experiments on crystallization of charged colloidal microspheres dispersed in density-matched and -unmatched media are compared to examine the influence of sedimentation. Results showed that the crystal size of the density-unmatched (namely, in the presence of sedimentation) sample grew faster than that of the density-matched (in the absence of sedi-mentation) case at the initial stage of the crystallization, and then the latter overtook and outstripped the former. Therefore, the sedimentation appears to accelerate the crystal size growth initially and then retard the growth. In addition, the crystal structures formed under microgravity were more closely packed than that in normal gravity.

By in-situ monitoring structural changes with the reflection spectrometer during the colloidal crystallization, we also present a direct experimental evidence of liquid-bcc-fcc phase transition in crystallization of charged colloidal particles, as a manifestation of the Ostwald's step rule. And we prove that all the fcc stable structures are transformed from the bcc metastable state. In addition, the lifetime of the bcc metastable structure decreases significantly with increasing particle volume fraction, which offers a possible explanation for "exceptions" to the step rule.