

The microgravity effect in colloidal phase separation

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Colloidal crystals are considered in the application to photonic crystals. The gravitational sedimentation method attracts great attention because of simplicity. It is thought that crystallization of colloidal crystals is caused by Kirkwood-Alder transition because of the repulsive interaction. However, to the colloidal dispersions in the conditions of low particle concentration and low ionic strength, void structure was generated 1) or gas-liquid-solid phase separation occurred 2). These phenomena cannot explain by only the repulsive force. The facts suggested the existence of a long-range attractive interaction between particles in spite of their repulsive pair potential. So, these results are very important.

The colloidal phase separation which arises in a gravity sedimentation process was reported 3). After like-charged colloidal particles sediment on glass substrate, colloidal particles cause gas-liquid-solid phase separation. A long-range attractive interaction between particles is required in order to bring out this phenomenon. However, in this experiment, when the phase separation of like-charged colloidal particles occurs, particles are always close to a glass substrate according to the gravity effect. Therefore, the interaction which works between particle-particles or between glass substrate-particles may be influenced by the gravity. So, in order to eliminate gravity effect, we experimented under microgravity.

3 μm polystyrene particles (Thermo scientific) were used. The density was 1.05 g/cm^3 . We compared the colloidal sample which was deionized one month or more by using Bio-Rad ion-exchanger resin and the untreated sample. Under the ground, the colloidal dispersion of 0.015 vol % was enclosed with the angle cell (10 mm x 10 mm x 47 mm), and 24 hours was settled. The angle cells were installed in the airplane. Then, the colloidal accumulations were observed in the microgravity environment about 20 seconds.

We measured the position change of colloidal particles. The diffusion coefficient by Brownian motion was calculated from these data. The diffusion coefficient of deionized sample was $0.082 \mu\text{m}^2/\text{s}$ and untreated sample was $0.137 \mu\text{m}^2/\text{s}$. On the other hand, the diffusion coefficient obtained from the Stokes rule was $0.14 \mu\text{m}^2/\text{s}$. The untreated sample was well in agreement with the diffusion coefficient obtained from the Stokes rule. When the value of a deionized sample and an untreated sample was compared, the direction of a deionized sample has a small value of a diffusion coefficient. In the deionized sample, we found a sign of the long range attractive interaction.

References

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