Relationship between particle morphology and mutual diffusion in liquid-liquid interfacial crystallization

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Powder particles are used for many industrial products such as medicine, cosmetics and food. With remarkable developments of chemical industries, materials with a high and new functionality have been produced by using powder processes. It is essential to precisely control the characteristics of powder particles for fabrication of new materials because the properties of the powder particles greatly affect the materials.

Build up process is mentioned as producing the particles and is roughly divided into three types: a gas phase, a liquid and a solid process. Liquid phase productions are better for obtaining high purity materials. Moreover, there is another advantage to synthesis of composite materials consisting of different components because the composition is easily controlled in the liquid phase processes. However, in conventional liquid phase processes, there are some problems which the size and shape of the particles have a broad distribution for fluctuations in temperature and concentration. Then, a liquid-liquid interfacial crystallization has proposed as a new crystallization technique. This technique can suppress the fluctuations by limiting the crystal precipitation field only at the liquid-liquid interface and enables to control particle morphology, minutely. It is very important to predict the particle morphology for the process design of the crystallization. However, it depends on empirical knowledge in the crystallization. Understanding of the mechanism of mutual diffusion and crystallization in liquid-liquid phase systems give a support to make the process design.

In this paper, particles were produced using various organic solvents in mutual solubility, and the differences in the particle characteristics was considered from a viewpoint of diffusion of solvent. The provided particle greatly differed in a particle form and particle diameter distribution, quantity of precipitation. Moreover, it turned out that these characteristics had the similar tendency with the organic solvent to be used. It was thought that this cause was what is depended on the degree of supersaturation arisen from solvent diffusion. Then, the diffusion velocities of water in organic solvent were calculated from results by pendant drop method and the concentration gradient of water near the interface was numerically showed by using diffusion equation. As a result, the concentration gradient is greatly dependent on mutual solubility, and a tendency accorded with the real crystal form. In the liquid-liquid interfacial crystallization, there is an association between the diffusion velocity and the particle separation, and it is possible to control particle morphology by choice of parameters such as organic solvent, solution concentration and operation time in the crystallization process.