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Morphological Control of NaCl Particle Using Laser Irradiation on a Levitated Droplet

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Summary

Recent manufacturing processes for high-performance crystal particles require the advanced control technologies of crystal structure and morphology. To develop the crystallization processes for the desired crystal particles, it is important to understand the crystallization behaviors from a microscopic viewpoint and actively control the nucleation and crystal growth in solution. We have studied the crystallization behavior of aqueous micro-droplet of NaCl solution using electrodynamic balance (EDB), where a charged droplet could be electrically levitated in space over the periods of hours. It enabled us in situ observation of crystallization behavior in a levitated micro-droplet with enough spatial and time resolutions. In this paper, we directly observed the nucleation and crystal growth in the aqueous NaCl microdroplet. It was found that the finally produced crystal particles had different several morphologies which were mainly influenced by the diameter and the charge of a levitated droplet.

The control of particle morphology is an important part of producing high quality products in industries. The operation of crystallization processes can be achieved by controlling supersaturation level in aqueous solution because it provides the driving force for both stages of nucleation and crystal growth. Most useful approach for optimizing the crystalline particle morphology is to precisely control the primary nucleation and then carefully to grow from the produced nuclei to crystals in an appropriate supersaturation solution to prevent secondary nucleation. Here we demonstrate potential for controlling particle morphology with laser-induced nucleation (LIN) in levitated micro-droplet that trapped in EDB. For primary nucleation control, LIN offers an attractive method of achieving well-controlled nucleation with temporally and spatially localization of the nuclei formation. In consequence, it enables the nucleation stage separately from the subsequent crystal growth stage. For crystal growth control, we use a levitated aqueous micro-droplet as small containerless crystallizer, in which supersaturation level could be quickly and easily controlled by adjusting its ambient relative humidity. We found that one shot laser pulse at relatively low fluence could initiate one nucleus in the levitated microdroplet of NaCl solution. As a result, we could successfully control the number of cubic crystal grains of the produced NaCl particle with a low number of laser shots. Our results demonstrate that the desired particle shape, which previously has not been obtained from droplet evaporation, could be created by simply controlling laser irradiation conditions. We anticipate our experimental method to be a starting point for more sophisticated, controllable, and economical micro-crystallizer in containerless..