論　文　の　要　旨

題　　目：SELF-ORGANIZED NANOSTRUCTURED PARTICLES FABRICATED FROM SPRAY-DRYING OF COLLOIDAL NANOPARTICLES

（コロイドナノ粒子の噴霧乾燥による自己組織化ナノ構造体微粒子の合成）

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An overview of my current research on the self-organized nanostructured particles fabricated from spray-drying of colloidal nanoparticles is described in this dissertation, which is believed to be the first detailed study on the structurization of nanostructured materials under effects of droplet charge. This dissertation is divided into four sections, in which each section comprises several chapters. The adjustment of several parameters to realize particles of varying morphologies is explained. Illustrations mechanism as well as theoretical explanation, is also described to support and clarify the design of particles.

Section 1 (i.e.**, Chapter 1)** is the introduction. Two kinds of droplet generation using spray drying methods (i.e. ultrasound-assisted and electrospray-assisted spray-drying methods) with their basic theoretical explanation and current progress in the production of particles are discussed.

Section 2, consisting of two chapters, describes the self-organization of colloidal nanoparticles under uncharged droplet condition. The synthesis of colloidal nanoparticles and its application in the fabrication of various self-organized hollow particles are described in detail, corresponding to **Chapter 2 and 3**, respectively.

In the first part of the **Section 2** (**Chapter 2**), the effect of nanoparticle charges on the self-organized nanostructured particles is described. Preparation of spherical-dense PS particles with controllable outer diameter and its application for particle templating application are reported. Particle formation and several parameters manipulation are also discussed. The prediction equation as a simple theoretical model on the effect of several parameters was also described to support the experimental result.

In the second part of **Section 2** (**Chapter 3**), effects of colloidal nanoparticles charge, size and concentration on fabrication of self-organized porous silica particles become the main focus of the study. Self-organization of colloidal nanoparticles in the formation of porous film form was studied. Comparison between theoretical calculation and experimental results on the arrangement of the particles was also presented. The calculation results were used for production of particles with controllable morphology.

Section 3, presenting the study self-organization of colloidal nanoparticles under charged droplet condition, comprises four chapters (**Chapter 4, 5**, **6** and **7**). The production of self-organized nanostructured particles with controllable size and morphology using a specific parameter manipulation under charged droplet condition becomes the main objective in this section.

In the first part of **Section 3** (**Chapter 4**), a high stability and controllability charged droplet generation system is developed. Control of charge over volume delivered to the system is essential for generation of stable and monodisperse charged droplets.

Chapter 5 explains the effects of droplet size and colloidal nanoparticles composition on the formation of core-shell silica/PS particles. Adjustment of colloidal nanoparticles composition and its effect on the core-shell particle morphology is the main focus of this chapter.

Chapter 6 explains the effects of droplet size and concentration on the formation of spherical hollow silica particles. Control of agglomeration-free condition of the produced hollow particles is achieved by adjustment of several parameters including the droplet size. The effectiveness of the hole size control by adjusting template hole size is also described.

Chapter 7 is the final chapter for **Section 3**. It describes the effects of droplet charge on fabrication of self-organized hollow silica particles from electrospray-drying of colloidal nanoparticles. Self-organization of nanoparticles inside a charged droplet and self-organization parameters (i.e. flow rate, charge, size, and composition of the colloidal nanoparticles) are also thoroughly investigated. The availability of the charge in the droplet surface provides possibility in formation of various morphologies in the fabricated particle with controllable outer shape, hole number, shell thickness, and internal structure.

Finally, **Section 4 (Chapter 8)** contains general conclusion of all topics, which has been described in the previous sections and chapters.