

Hideki SAKAI (Professor, Department of Pure and Applied Chemistry, Faculty of Science and Technology, Tokyo University of Science)

Purpose of Research

Silica hollow particles have excellent characteristics such as low density, low refractive index, substance encapsulation ability, etc., and are used in lightweight materials and heat insulation materials. If the particle size can be controlled to be 100 nm or smaller, they can be expected to be applied to anti-reflection coatings and the carriers of drug delivery systems (DDS). One method of synthesizing silica hollow particles is the soft template method, which uses molecular assemblies formed by surfactant as templates, and research into this method has been actively conducted in recent years as this process is easy to do and substances are easily encapsulated in the hollow space. However, the low dispersion stability of the manufactured hollow particles has been a challenge in improving this method. In this study, we used vesicles as a soft template and aimed to synthesize silica hollow nanoparticles with excellent dispersion stability by changing pH stepwise during the forming period of silica.

Summary of Research

This technology is related to the soft template method for producing hollow silica particles, using vesicles formed by surfactant as templates. By changing the pH of the manufacturing process stepwise, hollow silica particles with a uniform diameter of 100 nm or below can be obtained. In this method, vesicles are used as templates so that various substances can be supported inside the hollow silica particles. By controlling retention and release, the particles can be made to adapt to various applications.

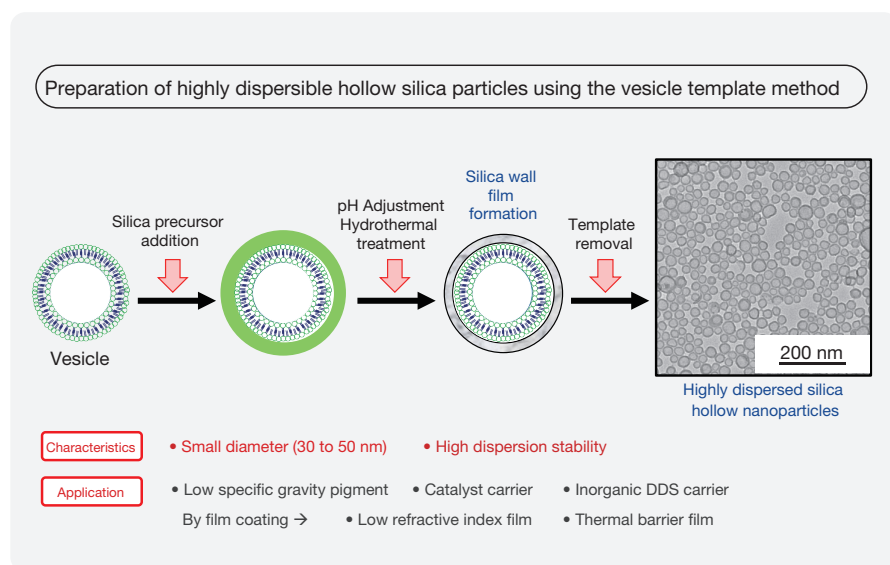


Figure: Preparation of silica hollow nanoparticles with vesicles as templates

Comparison with Conventional or Competitive Technology

- Conventional: The majority is manufactured by the hard template method.
- Conventional method: It is difficult to encapsulate substances inside the silica particles, and applications were limited to their properties as “hollow” silica particles.
- This technology: Both “hollow” and “encapsulating substances” silica particles can be developed to meet various needs.

Expected Applications

- Inorganic anti-reflection film making use of low refractive index characteristics
- Inorganic DDS material for diagnosis
- Development into thermal barrier/thermal insulation paint
- Supported type catalyst

Challenges in Implementation

- Small amount of surfactant remains even after washing
→ Establishment of complete removal method

What We Expect from Companies

We seek cooperation with industries in fields working in low refractive index inorganic films, transparent thermal barrier films, highly dispersible pigments, etc. in hollow particle formation and application of not only silica, but also other various materials.

Also, we hope to cooperate with industry for the development of silica particles for DDS, which include diagnostic reagents.

Points

- Nano-sized hollow particles can be prepared by a facile process
- Substances can be supported inside hollow silica particles
- Excellent dispersion stability is retained in water system (Stable dispersion for 1 year or more)
- Suitable for coating processes etc. and superior in environmental affinity

Future Developments

- November 2017 Start cooperation with companies
- October 2018 Completed method for preparing hollow particles other than silica
- January 2020 Start sales of silica hollow particles

- Awards: JACM Annual Conference, Gold Poster Awards
- Intellectual Property: Japanese Patent Application No. 2014-166604, Japanese Unexamined patent Application Publication No. 2016-041643
“Method for Producing Hollow Silica Particles and Hollow Silica Particles”
- Prototype: Not available
- Sample: Available

