

Morphology and Size Control of Mesoporous ORMOSIL Particles Prepared from Ternary Organosilane Mixture

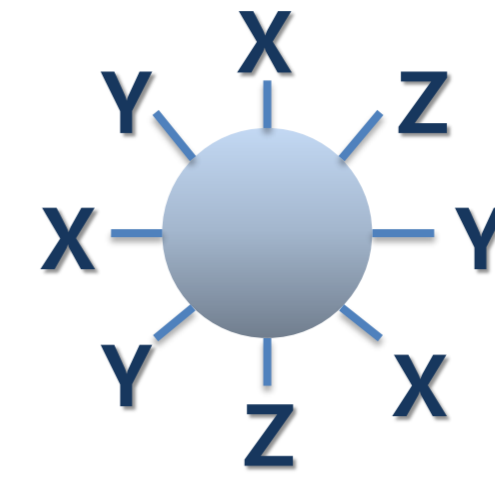


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Introduction

- ❖ Nanostructured materials with tailored morphologies and sizes have attracted intense interest in diverse field of nanotechnology due to their novel properties, such as large surface area, controlled pores and channels, permeability, and low density.
- ❖ Facile, economic, and general, without using external templates, methods have to be developed to synthesize tailored nanostructured ORMOSIL particles, such as raspberry shaped, hollow, and rattle type structures.

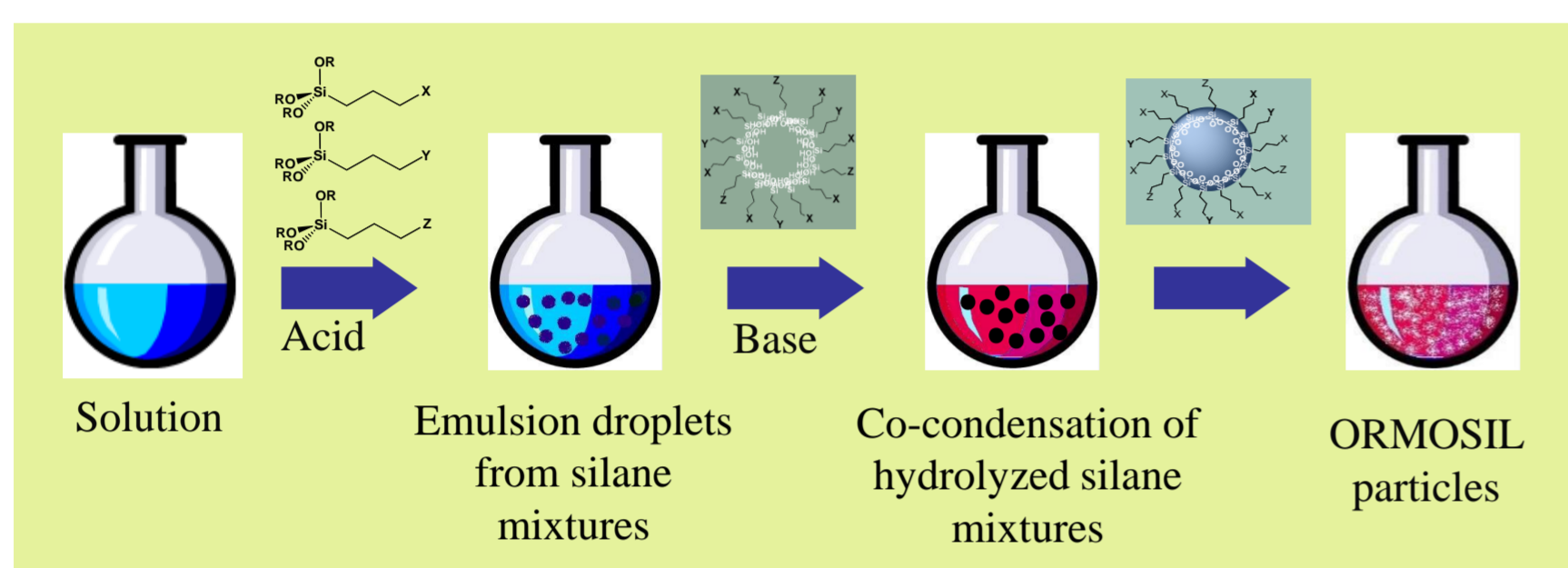
❖ *Organically Modified Silica (ORMOSIL) particles as templates for mesoporous particles*



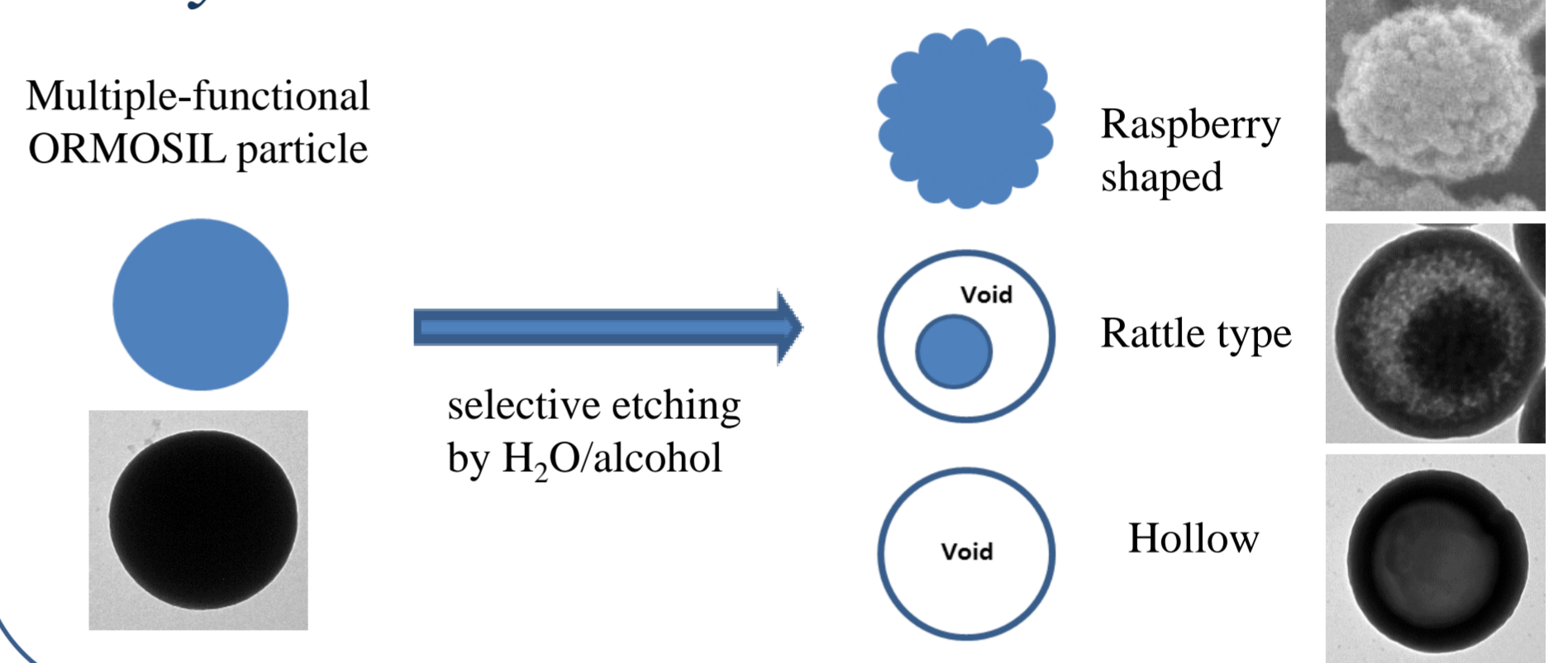
X and/or Y (major component) → Phenyl, Vinyl, Mercapto, Methyl, etc.
Z (minor components) → Amine, Epoxy, Methacrylate, etc.

Experimental

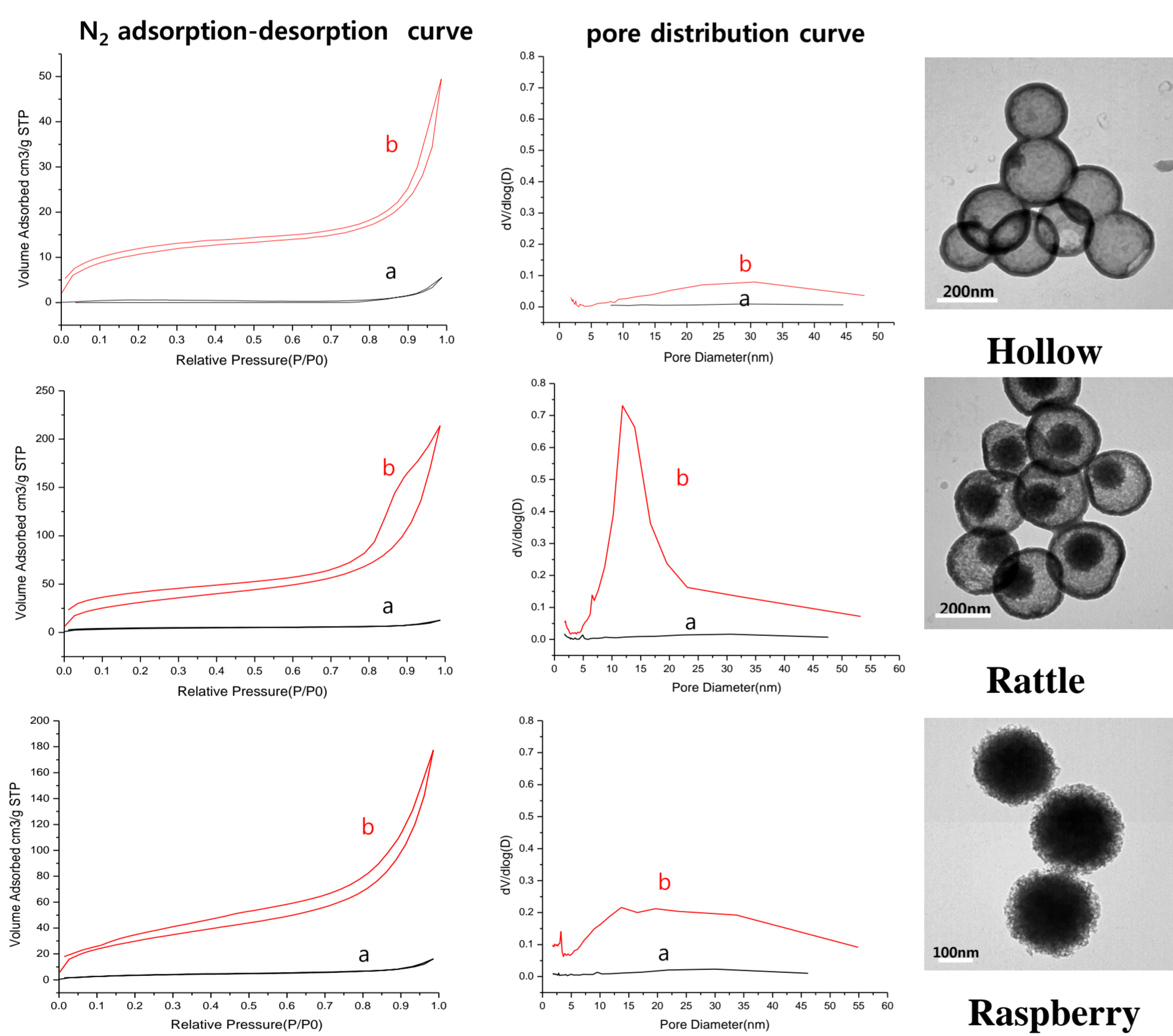
Preparation of ternary ORMOSIL particles



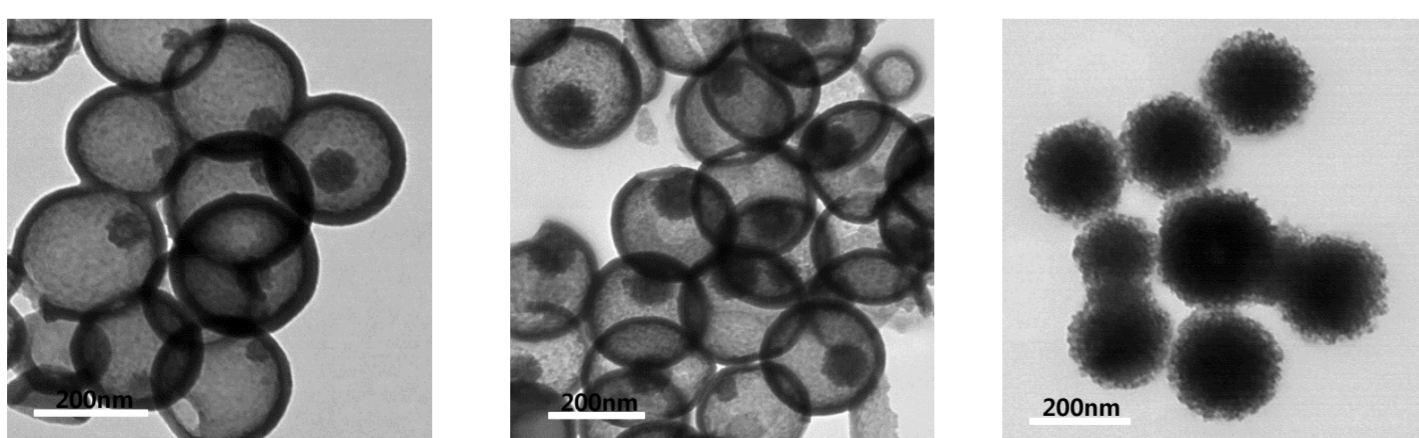
Formation of mesoporous ORMOSIL particles by selective dissolution



BET N₂ adsorption-desorption analysis analyses of mesoporous nanostructured ORMOSIL particles



After heat treatment at 600 °C



Variation in the morphology and size of mesoporous particles depending on the relative ratio of organosilanes in ternary ORMOSIL particles. (P:PTMS, V:VTMS, A:APTMS)

	P/V (3.5/1.5)	P/V (2.5/2.5)	P/V (1.5/3.5)	P/V (1/4)	P/V (0.5/4.5)	
A (0.5)						
A (1.5)						
Ratio of PTMS / VTMS (ml)	P/V (3.5/1.5)	P/V (2.5/2.5)	P/V (1.5/3.5)	P/V (1/4)	P/V (0.5/4.5)	
A (0.5)	Shape	Sphere	Sphere	Rattle	Raspberry	Raspberry
A (0.5)	Size (nm)	373 (±9)	347 (±9)	309 (±14)	301 (±19)	291 (±8)
A (1.5)	Shape	Hollow	Rattle	Rattle	Rattle	Raspberry
A (1.5)	Size (nm)	198 (±9)	328 (±18)	222 (±18)	267 (±12)	223 (±19)

Conclusions

- ✓ Tailored mesoporous ORMOSIL particles, having various morphologies, such as raspberry shaped, hollow, and rattle type structures, were synthesized by a selective dissolution of organosiloxane networks in ternary ORMOSIL particles prepared using a simple two-step process.
- ✓ The first step, synthesis of monodisperse ORMOSIL particles with multi-layered structure, comprised a one-pot process in an aqueous solution using ternary mixture from three organosilane monomers, 3-aminopropyl-trimethoxysilane (APTMS), vinyltrimethoxysilane (VTMS), and phenyltrimethoxysilane (PTMS). In the second step, the ORMOSIL particles were treated with a mixture of water and alcohol with mild heating.
- ✓ The size and morphology of mesoporous ORMOSIL particles could be easily adjusted by simply changing the relative ratios of PTMS, VTMS and APTMS in reaction mixture for ORMOSIL particles.
- ✓ These mesoporous ORMOSIL particles were converted to mesoporous silica particles, maintaining morphologies, simply by the heat treatment at 600 °C in air.