Dynamic Nanostructural Transformation of Meso/Macroporous Materials for Flexible Templating

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Templating synthesis is one of the most important concept for the control of nanostructured materials, though the nanostructural variety of products is limited in those of templates. Here, I would like to introduce recent progress in flexible templating, in which a template changes its structure by the interactions with replicated materials. It will overcome the limitation of the nanostructural varieties.

The first example is based on the cleavage of colloidal crystals.[1,2] When gold is deposited by chemical reduction of $HAuCl_4$ in the mesoporous interstices of silica nanospheres, the colloidal crystal is spontaneously cleaved along specific crystallographic plane (Fig. 1). Gold grows two-dimensionally in the crack to form nanoplate possessing periodic dimples on the surface. The cleavage, a sort of nanostructural change, depends on the nanostructure of the colloidal crystals, which can be explained by the density of interparticle connections on each facet.

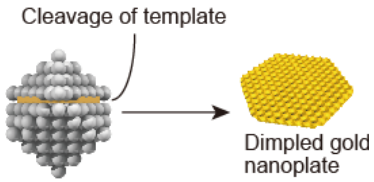

Fig. 1. Flexible templating using colloidal crystal as a template.

The second example is based on the deformation of porous polymer templates.[3] A macroporous polymer thin film, possessing random semispherical macropores on the surface, is prepared by breath figure. The semispherical macropores are partially filled with silica nanoparticles, followed by calcination to remove the polymer template. Interestingly, the silica nanoparticles formed one-dimensional networks after the calcination (Fig. 2). It was revealed that the deformation of the surface macropores to close the remaining space caused movement and self-organization of silica nanoparticles. The self-organization behavior is also controlled by sequential heat treatment.

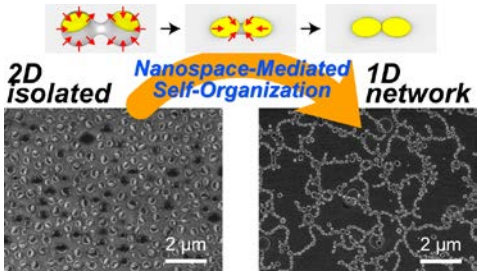

Fig. 2. Flexible templating using macroporous polymer template.

These examples show that meso/macroporous templates have unique transformation modes. Various unexpected nanostructures will be controlled by using such a flexibility of templates.

References

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