Bubble Template Method for Synthesis of Hollow particles

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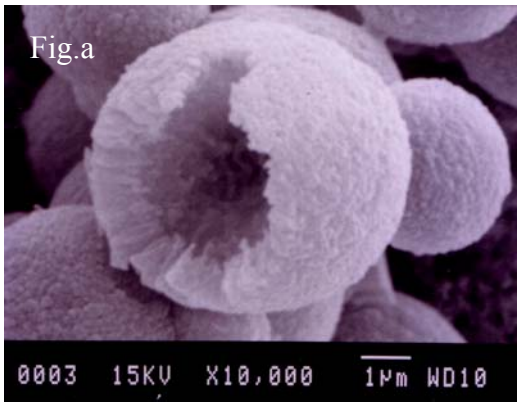
STATE OF THE ARTS

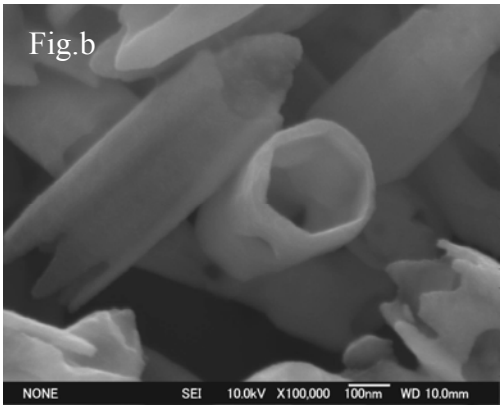
A new method to synthesize hollow particles has been proposed in our group with the nomination of bubble template method. Several kinds of hollow particles have been prepared by this new method through passing inorganic bubbles into aqueous solutions. The bubbles used in this method are not only reagent, but also the templates for the formation of hollow particles. When single ammonia bubbles was passed into silica sol, a spherical silica gel was formed around the pre-formed bubble, which indicated that the bubble surface have a higher concentration of ammonia ions, leading to a preferred gelation on the surface of bubble. The heterogeneous chemical of bubble surface is expected to play an important role on the formation of hollow particles on the surface of bubble. When CO_2/N_2 was passed into calcium chloride solution, hollow spherical calcium carbonate ($CaCO_3$) particles were synthesized with the diameter of 3-5μm, shell thickness of 200-300nm, as shown in Fig.a. These hollow particles were observed to be formed by assembling nano-sized primary particles on the surface of bubbles. The primary particles were initial precipitates of calcium carbonate, which were formed by the reaction of calcium ions and carbonate ions and preferred to congregate together at surface of bubble to reach a minimum of total surface areas. When ammonia bubbles were passed into zinc chloride solution, single crystalline zinc oxide tubes were synthesized with a length of 1-3μm, a diameter of 200-300nm, wall thickness of 30-50nm, as shown in Fig.b. The formation of ZnO tubes were speculated to be relative with the special features of flowing bubbles and crystal growth of ZnO. As a bubble rises in a solution, the fluid sweeps through the front and side of bubble except its rear. Hence the rear of bubble is the most stable area, where precipitates adsorption is firstly started, forming a bowl-like coating. Following reactive ions, such as zinc ions and hydroxyl, carried by fluids, come to the edge of coating and form new precipitates. Owing to the ZnO crystal prefers to grow along c-axis, the new precipitates contribute to the growth of ZnO at one direction, forming rode-like particles. The formation of ZnO tubes instead of ZnO rodes was attributed to the rich of reactive ions on the edge of coating and more sharing elements there for connecting the new growth unites.

Even through various hollow particles have been prepared by this new method, the exactly mechanism and further improvements of this method is still in the investigation. For

examples, the factors controlling the formation of hollow particles, the addition of surfactants and the investigation on mechanism are being studied now. Further results are expected to be reported in the near future.



Hollow $CaCO_3$



ZnO tubes

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