Encapsulation of low-density aerogel

Fuyumi ITO

Highly spherical (98.5%) low-density foam balls with 1-mm diameter were fabricated from a density-matched capsule consisting of a resorcinol/formaldehyde (RF) aqueous solution and a mineral oil-carbon tetrachloride mixture. However, highly sphere with a uniform wall thickness could not be obtained because the density matching was lost during the heating.

In this study, a phase-transfer catalyst for RF gelation is applied, and then the density matching is maintained during a cross-linking reaction. The phase-transfer catalysts of carboxylic acid and alkyl amine were utilized to induce a gelation of the capsule at room temperature. When several different types of the basic catalyst were used at room temperature as the phase-transfer catalyst, the gelation occurred within 30~120 min, while when several different types of the acidic catalyst were used, the gelation occurred within 20~30 min at room temperature. It was apparent that the smoothing of the generated capsule surface obtained by using basic catalyst was better than that obtained by acidic catalyst.

In the next step, we studied the gelation of RF foam capsule using density-match non-volatile silicon oil in addition to the phase-transfer catalyst. The capsule was injected into a drum containing a mixture of 0.39 wt% acetic acid and silicon oil. An optimum rotational speed was searched in order to obtain desirable spherical capsules. As a result, it was obtained that the drum rotational speed was increased to 95 rpm within 15 minutes, and five minutes later, the rotational speed was increased to 120 rpm once again, which was maintained for 1 minute, there after it reduced to 95 rpm for 39 minutes. Finally, highly spherical and uniform-thickness capsules were obtained.

In order to obtain an ideal thickness and size of the capsules, a viscosity of the RF solution was considered. As it was clarified that the viscosity of the RF solution (9 x 10-6 m2/s) was fairly low, a survey and experiments were carried out to prepare highly viscous RF solution. The viscous RF solution, however, easily underwent the cross-linking reaction. We have adopted a linear copolymer solution of phloroglucinol carboxylic acid and formaldehyde (PF)(= 2.9 x 10-4 m2/s), of which structure was similar to that of the RF solution, in order to circumvent the cross-linking reaction of the RF solution. The ideal capsules with highly sphere and wall thickness was obtained using this solution in success.