Porous poly(ε-caprolactone) hollow microspheres with different morphologies

Tae-Sik Jang, Eun-Jung Lee, Hyoun-Ee Kim
Department of Materials Science and Engineering, Seoul National University, Seoul, Korea

Statement of Purpose: Recently, many studies have been carried out to develop hollow microspheres for drug delivery systems due to their attractive characteristics, such as low density, large specific surface area and usefulness of inner spaces [1]. In general, hollow microspheres are prepared by using templates, or by the self-assembly processes. In these cases, however, the core removal steps to form inner space were complex and several chemical agents were needed to make stable emulsion [2]. Therefore, economic, novel and simple methods to prepare hollow microspheres are still being sought. Here we report porous hollow PCL microspheres fabricated via a simple solvent/non-solvent emulsion solvent extraction technique. By controlling the concentration of PCL solution, microsphere morphologies were readily modulated.

Methods: Hollow microspheres were prepared by a modified solvent/non-solvent emulsion technique. Various weights of PCL (0.6-1 g) were completely dissolved in o-xylene (5 ml). These polymer solutions were loaded in syringes and continually injected into ethanol by infusion pump. A stainless needle was contacted with the ethanol bath. After completely extracting o-xylene with a gentle stirring, solidified microspheres were filtered and vacuum-dried during 1 day.

Results: Fig. 1 shows the surface and internal structures of microspheres obtained from different PCL concentrations (20% and 16% w/v). All the microspheres possessed spherical shape and rough surface with many small cavities [Fig. 1(a) and (c)]. Fig. 1(b) and (d) reveal the internal pore structures of the PCL microspheres. In the case of 20% w/v PCL, small pores connect with each other and homogenously distributed throughout the whole spheres. In contrast, large pores were observed in the PCL microspheres (16% w/v) [Fig. 1(d)].

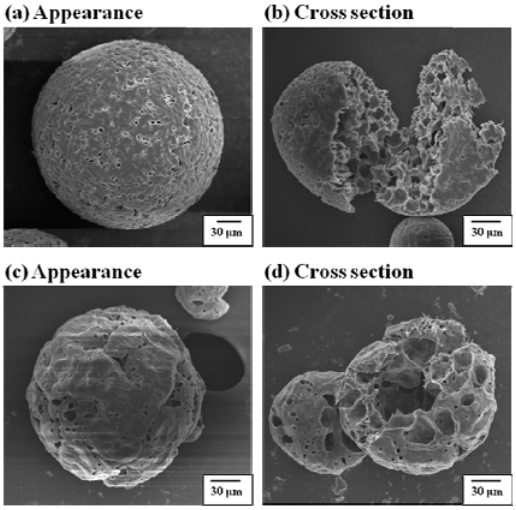

Fig. 1. SEM images of porous microspheres obtained at 20% w/v (a-b) and 16% w/v (c-d) PCL concentration.

Fig. 2 shows the surface and internal structures of microspheres from a solution with PCL concentration of 12% w/v. It can be seen that the surface is highly porous [Fig. 1(b)], the internal structure is hollow, and the polymer shell layer has a 'sponge-like' porous structure. The irregular pores are connected with each other and homogenously distributed throughout the shell structures [Fig. 1(c)].

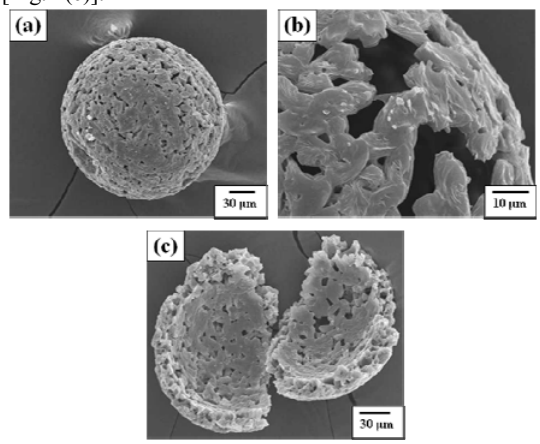

Fig. 2. SEM images of hollow microspheres. (a) Appearance, (b) surface, and (c) cross section.

These results indicate that solvent/non-solvent emulsion technique with o-xylene and ethanol is extremely simple and effective to fabricate porous and porous hollow microspheres.

Conclusions: Hollow PCL microspheres with a porous wall were fabricated by a solvent/non-solvent emulsion technique. Different microsphere morphologies were readily modulated by altering the concentration of PCL. Hollow microspheres possessing a porous polymer shell layer may have potential applications as devices for controlled local delivery of drugs and proteins.

Reference

1. Yoo HS. Colloid Surface B 2006;52:47-51.
2. Huang X et al. Polym Int 2008;57:449-453.
3. Gao C et al. Polym Adv Techonol 2005;16:622-627.