Studies on Characterization of Aliphatic polyesters-Based New Materials and Application to Drug Delivery System

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1. Introduction

Aliphatic polyesters are promising materials because they degrade with and without enzyme and have nice miscible character with other polymeric materials. Therefore, they are expected as ecological materials that would not be harmful to earth environment. On the other hand, the degradation in the human body enables application to controlled release system of bioactive molecule that needs long time treatment. In this study, we precisely characterized aliphatic polyesters-based materials and investigated application to drug delivery system.

To achieve the purpose, we prepared thermally stable cross-linked materials via preparation of branched macromonomers followed by cross-linking reaction. We studied physicochemical properties, accompanied with the degradation process that related to temperature. Moreover, we developed very unique thermo-responsive materials using the typical aliphatic polyester, poly(ε-caprolactone) (abbreviated as PCL) and poly(isopropylacrylamide) (abbreviated as PIPAAm). PCL is well known as a semi-crystalline polymer and shows very clear melting point. On the other hand, PIPAAm can show very clear thermo-responsive property based on completely reversible swelling-deswelling change. By combination of the PCL and PIPAAm, we realized the unique thermo-responsive polymeric materials.

2. Results and Discussions

First, we prepared cross-linked aliphatic polyester derived from the branched poly(ε-caprolactone (CL)-co-D,L-lactide (LA)) macromonomers with different CL and LA compositions. Because we considered that composition of the materials would be dominant factors in physico-chemical characters.

Using the prepared materials, we traced the thermal properties accompanied the material degradation by means of differential scanning calorimetry. Interestingly, the degradation occurred in the amorphous domain that was formed by PLA dominantly and as a result total crystallinity of the materials improved. Therefore, the degradation very closely related to the temperature. It has been understood that the degradation doesn't happen below the melting point, and the degradation proceeded above the melting point. So, taking advantage of this result, we prepared composite materials comprising poly (ε-caprolactone) (PCL) homopolymer with crystalline structure and poly (D,L-lactide) (PLA) with amorphous structure. Expectedly, we succeeded preparation of porous materials that the porosity or pore size were controlled by blending condition.

Also, we built up and characterized new drug delivery system that was prepared by combining PCL and PIPAAm. Described above, PCL shows crystalline melting phenomenon and PIPAAm occurs coil-globule transition at lower critical solution temperature (LCST). As a results, we succeeded that preparation of the newly material having off-on-off drug release by grafting PIPAAm chains onto PCL membrane surface. In this materials, hydrophilic drug could permeate only above melting point of PCL and below LCST.

3. Conclusions

In this study, we designed cross-linked aliphatic polyesters-based materials, and the traced degradation as a function of temperature. The precise characterization enabled the preparation of the porous materials with controlled porosity and pore size. Moreover, we newly designed the thermo-responsive materials that showed limited permeation at designed temperature range using PCL and PIPAAm.