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Chemoenzymatic synthesis of polysaccharide-grafted polymeric materials

Biological macromolecules, such as polysaccharide and protein (peptide), are vital materials in living systems. Such functions are appeared by their controlled primary and higher-ordered structures. Furthermore, branched or grafted biological polymers are often appeared in nature and such complicated structures contribute to exhibiting important in vivo functions. Accordingly, synthetic method for combining several biological macromolecules into branching or grafting is expected to produce new functional polymers. On the basis of the viewpoint, we have reported the synthesis of amylose-grafted polymeric materials by chemoenzymatic approach, which is a combined method of phosphorylase, catalyzed enzymatic polymerization of α -D-glucose 1-phosphate (G-1-P) monomer for the amylose production with appropriate chemical reactions. The phosphorylase-catalyzed enzymatic polymerization using G-1-P as a monomer proceeds with the construction of α -glycosidic bond under mild conditions, leading to the direct formation of α -(1-4)-glucan chain, i.e., amylose, in the aqueous media. To initiate the polymerization, a maltooligosaccharide is required as a primer in the initial reaction media. The synthesis of amylose-grafted heteropolysaccharides has been performed by combining the phosphorylase-catalyzed enzymatic polymerization with the appropriate chemical reaction (chemoenzymatic method). For example, amylose-grafted carboxymethyl cellulose (CMC) was synthesized as the following chemoenzymatic method. A maltooligosaccharide having an amino group was first introduced to the CMC by using condensing agent. Then, the phosphorylase-catalyzed enzymatic polymerization of G-1-P from the maltooligosaccharide chain ends on the product was performed to obtain the desired amylose-grafted CMC. The product had the rigid CMC main chain, which further assembled, leading to nanobeads by the formation of double helix between the long amylose graft chains in the intermolecular CMC chains. The chemoenzymatic synthesis of amylose-grafted poly-L-glutamic acid (PGA) as a new artificial polysaccharide-polypeptide conjugate was also investigated. The product formed a robust hydrogel, which could be converted into a regularly controlled porous material.

Biography

Jun-Ichi Kadokawa holds PhD degree in Engineering. Currently, he is a Professor of Chemistry, Biotechnology and Chemical Engineering at Kagoshima University, Japan. He studied applied chemistry and materials chemistry at Tohoku University, where he received his MS degree in 1989 and PhD in 1992. He has then joined Yamagata University as a Research Associate. From 1996 to 1997, he has worked as a Visiting Scientist at the Max-Planck-Institute for Polymer Research in Germany. In 1999, he became an Associate Professor at Yamagata University and moved to Tohoku University in 2002. He was appointed as a Professor of Kagoshima University in 2004. His research interests focus on enzymatic synthesis of functional oligo- and polysaccharides and control of their higher-ordered structures. He has received the award for Encouragement of Research in Polymer Science (1997) and the Cellulose Society of Japan award (2009).

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