

Synthesis and Characterization of Acrylic Polymer Containing Silk Protein

Zhongmin Chen⁽¹⁾, Mutsumi Kimura⁽¹⁾, Masahiro Suzuki⁽²⁾, Yoshiyuki Kondo⁽¹⁾,
Kenji Hanabusa⁽²⁾, Hirofusa Shirai⁽¹⁾

(1) Department of Functional Polymer Science, Faculty of Textile Science and Technology, Shinshu University, Ueda 386-8567, Japan

(2) Graduate School of Science and Technology, Shinshu University, Ueda 386-8567, Japan

Abstract

Three kinds of acrylic polymers containing silk protein were synthesized, which are (1) blending of silk fibroin (SF) fiber and polyacrylonitrile (PAN); (2) graft-copolymer of PAN onto SFs; (3) random-copolymer synthesized by copolymerization of acrylonitrile (AN) and silk fibroin peptide (SFP) with vinyl groups, and their solubility, thermal property, and moisture absorption was investigated, respectively. These polymers have difference solubility and attributable to their structure. Their excellent thermal stabilities and better moisture absorptions were indicated.

Introduction

In recent years there has been increasing interest in the combination of PAN and silk protein. PAN has some merits of cheap price and good mechanical property, and also has many demerits such as low dyeing affinity and moisture absorption, etc. On the other hand, Bombyx mori silk fibroin fibers show excellent luster, tensility, handling, and moisture absorption, but they have some demerits such as expensiveness, poor wrinkle recovery, etc. To improve the demerits of each polymer, new functional polymers consisting of combination of silk fibroin (SF) and PAN have been developed. The synthetic strategies reported are mainly classified into two methods: (1) blending of SFs and AN-based polymers and (2) graft-polymerization of AN onto SFs. In this paper, we devise a new method in combining PAN and SF protein. And the characterization of the copolymer synthesized by using new method was compared with those of blending and grafting polymers.

Experimental

Preparation of acrylic polymer containing silk protein is as follows: (1) SF fiber and PAN is dissolved in 60wt% ZnCl₂ solution, respectively. And then mix them and collect by diluted HCl aqueous solution. (2) SF fiber is dissolved in ZnCl₂ solution, and add AN and ammonium persulfate. The result solution is collected by diluted HCl aqueous solution. (3) The SF powder was decomposed with enzyme to form silk fibroin peptide (SFP). And then SFP macromonomer was prepared by acylation of the SFP with acryloyl chloride. The copolymerization of SFP macromonomer and AN was performed in 60wt% ZnCl₂ aqueous solution.

Results and discussion

First, from FTIR absorption peaks, these polymers synthesized by three methods are copolymers combining SF and PAN segments. Second, the copolymers synthesized by three methods indicated difference solubility and could be explained by their structures. The blend compound has a structure that the SF is dispersed PAN, and the PAN chains in graft-polymer are elongated from the SF as a center, the new copolymer has a covalently cross-linking structure by SFP. The weight of these copolymers began to loss is at about 290°C, and the weight residues of these copolymers are larger than PAN, indicated excellent thermal stabilities. Finally, these copolymers show better moisture absorption.

Acknowledgments

This work was supported by a Grant-in-Aid for COE research (10 CE 2003) by the Ministry of Education, Culture, Sports, Science, and Technology of Japan