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Preparation and Characteristics of Polyethylene Films Containing Superfine Particles (Part 1)

Hideki SAKAI*,**,†, Akira SATO*,***, Masamitsu NAGAHAMA*** and Masahiko ABE*,**

*Faculty of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba 278-8510, Japan
**Research Institute of Science and Technology, Tokyo University of Science, 1-3 Kagurazaka, Shinjuku, Tokyo 162-8601, Japan
***Acteive Co., 2641 Yamazaki, Noda, Chiba 278-8510, Japan
†Corresponding Author, E-mail: hisakai@rs.noda.tus.ac.jp

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Abstract

Polyethylene (PE, an olefinic polymer) films were prepared with added superfine particles (liposomes: diameter ca. 200 nm) and the effect of added liposomes was examined on the film properties. When added liposmes contained porous sodium aluminosilicate as a CO_2-absorbing nucleus substance and sodium 2,2'-methylene-bis-(4,6-di-tert-butylphenyl) phosphate as an enhancer of PE crystal nucleus formation, the mechanical strength of prepared PE films was found to be improved due to an incresed degree of crystallization. In addition, the amount of CO_2 generated in combustion tests that simulate combustion in incinerator was about 60% less for the PE films containing liposomes than for those with no liposome.

Key-words: *Polyethylene, Liposome, CO_2 reduction*

1. Introduction

Global air pollution, especially that caused by increased carbon dioxide emission, has become one of the most serious problems in our society and national projects (use of natural energy) toward a low carbon society have recently started to work. Nevertheless, some more time is still needed before effective means are developed for reducing carbon dioxide emission. At present, one of the surest means for carbon dioxide reduction is to decrease the amount of carbon dioxide generated when various polymer films used as packing material, shopping bag, garbage bag, etc. are burned in incinerator. Presently available methods for carbon dioxide reduction are chemical ones such as the use of adsorption apparatus filled with CO_2-absorbing material and addition of certain additives to wastes to be burned.

The present authors have examined a relatively simple chemical method in which certain chemical substances are added to reduce carbon dioxide emission. It is important to disperse the chemical substance uniformly in the subject polymer as superfine particles in this method. The mixing of the pulverized substance with the polymer alone is unsuitable because it causes secondary particle aggregation. Liposomes[1], nano-sized capsules usually used as a drug carrier in drug delivery systems, have been taken up and used as a carrier (nanocapsular polymer filler) of the compound for improving polymer quality in the present work. The liposomes used are those prepared by the reverse phase evaporation method using supercritical carbon dioxide fluid[2-5]. This method allows to prepare liposomes in large amounts in a short time. The use of inorganic compound as the nucleus substance of liposomes is the first attempt in the world.

2. Experimental

2.1 Materials

The polymer used was high density PE (Prime Polymer Co., Highzex 50000SF). Sodium aluminate (Wako Pure Chemicals Ind., reagent grade) and sodium silicate (Wako Pure Chemicals Ind., reagent grade) were used as the nucleus substances. The enhancer for crystal nucleus formation used was sodium 2,2'-methylene-bis-(4,6-di-tert-butylphenyl)phosphate (ADEKA, NA-11).

2.2 Methods

2.2.1 Preparation of nanocapsular polymer filler

Sodium aluminate (6 g) and sodium silicate (30 g) were dissolved in water (130 g) and the mixture was stirred at 30 ℃ for 60 min. Centrifugation of the stirred mixture gave amorphous sodium aluminosilicate. Nanocapsular polymer filler (liposomes) containing the amorphous sodium aluminosilicate and sodium 2,2'-methylene-bis-(4,6-di-tert-butylphenyl) phosphate were then prepared using the reverse phase evaporation apparatus[5].

2.2.2 Measurements of nanocapsular polymer filler particle size

The particle size of the prepared nanocapsular polymer filler was measured with a particle size analyzer (Particle