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# Preparation and Characteristics of Polyamide Containing Superfine Particles

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**Abstract**

Polyamide (PA) sheets with superfine particles containing polymethylphenylsiloxane as the core substance (nanocapsular polymer filler: diameter about 250 nm) were prepared and the effects of the polymer filler on the properties of PA were investigated to improve the transparency of PA. The tensile strength of PA sheet was improved by about 20%. Moreover, the clarity of the sheet was found to increase by about 10 times due to the diminished visible light scattering caused by the formation of tiny PA crystals uniformly dispersed in the polymer. On the other hand, the addition of non-encapsulated polymer filler yielded opaque sheets because of grown PA crystals. These findings indicated the importance of the addition of uniform dispersion of nano-sized core substance particles to the polymer. In particular, the addition of liposomes containing polymethylphenylsiloxane (nanocapsular polymer filler) was found to be important to make PA sheet transparent and improve its tensile strength.

***Key-words***: *Polyamide, Liposome, Transparency, Tensilestrength*

## 1. Introduction

In earlier papers[1,2], we have reported that the uniform dispersion of superfine nanocapsular polymer filler in polyethylene (PE) allows the improvement of the properties of the polymer. Actually, we observed a reduced $CO_2$ gas generation during the combustion of processed PE sheets, an increased tensile strength and a high UV absorbability of the sheet, and the mixing ability of PE with starch. The polymer modifying method we have developed is to efficiently disperse superfine particles (core substance with functions such as improving strength) in the target polymer, thereby increasing the effect of core substance on the polymer. As the target polymer for those studies we chose PE as it is widely used in everyday commodity goods since the polymer is easily molded. This paper deals with the modification of polyamide (PA), which is extensively used as a multifunctional engineering polymer, because the nanocapsular polymer filler is likely to be applicable to polymers other than PE.

PA is used presently in fibers, films, car parts and electronic appliances, etc. because of its excellent mechanical properties, thermal resistance, oil resistance, and gas impermeability. As the field of PA applications has expanded, the demand for improvements in its clarity has been increasing because the polymer is crystalline and crystals formed and grown in the polymer scatter visible light to make it opaque. While a solution for this problem is to rapidly cool the melted non-crystalline polymer at the time of molding to produce transparent goods, the properties of the polymer gradually deteriorate in the non-crystalline state. If the polymer can be allowed to grow as superfine crystals instead of letting it turn into the non-crystalline state, highly transparent PA would be obtained while keeping the scattering of visible light diminished.

Fine particles (nanocapsular polymer filler), containing polymethylphenylsiloxane as the core substance encapsulated in nano-sized liposomes[3], were prepared by the supercritical reverse evaporation method[3] in the present work. In addition, the prepared nanocapsular polymer filler was added to PA and the effects of the filler were investigated by evaluating the transparency, mechanical properties, crystallinity, and crystalline state of the resultant polymer sheet.

## 2. Experimental

### 2.1 Materials

The polymer used in this work was copolymerized 6/66 polyamide resin (Mitsubishi Engineering-Plastics Corporation, Novamide 2030A). The core substance employed was polymethylphenylsiloxane (Toray・Dow Corning, SH710).

The source of liposomes employed was L-α-Dipalmitoylphosphatidylcholine (DPPC, Wako Pure Chemical Ind).

### 2.2 Methods

2.2.1 Preparation of nanocapsular polymer filler

After DPPC (1 g), polymethylphenylsiloxane (6 g) and water (100 g) ware placed in a reverse phase evaporation apparatus[5], $CO_2$ was introduced into the apparatus. The