APPLICATION OF LOW TACTICITY POLYPROPYLENE TO NON-WOVEN FABRICS AND FILM

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Abstract

Novel polypropylene having very low isotacticity, low modulus and narrow molecular weight distribution (LMPP) was obtained using the specific C_2 symmetric metallocene complexes.

Spunbond non-woven fabrics using this novel polypropylene had high elastic recovery which reached 85% using bi-component (BICO) or multi- layered structure under high line speed.

A small amount of very low tacticity polypropylene added to standard PP improved the spinnability and could produce very fine denier and soft touched non-woven fabrics. It has a potential of reducing non-woven fabrics weight.

It was also added to the biaxially oriented polypropylene grade (BOPP). Blending of very low tacticity PP to BOPP influenced spherulite size and lamella thickness and decreased the yield stress of stretching force and the stress at the high stretching strain without reducing melt temperature which improves film thickness uniformity and prevents film break during the stretching process.

1. Introduction

Low isotacticity and low modulus polypropylene (LMPP) was studied the applications for high elastic recovery non-woven fabrics and for improving the spinnability and stretchability by adding a small amount of LMPP to conventional PP. LMPP has potentials to be used a disposal diaper, a sanitary napkin, hygiene products, bandages and biaxially oriented films. This paper introduces textile and non-woven fabrics and film application and their physical properties.

2. Experimental

LMPP(M_w=110000, M_w/M_n=2.0, T_m=70C) was polymerized by using the specific C_2 symmetric metallocene complexes. In terms of processability and physical properties, Primepolymer iso-PP Y6005GM (MFR=60, T_m=165℃) as a spinning grade and F300SP （MFR=3、Tm＝161℃）and F300SV（MFR=3,Tm ＝165℃） as biaxially oriented film grades were blended to LMPP. Reicofil 4 (#4 generation machine of Reicofil Co., Ltd.) was used to produce the spunbond non-woven fabrics. The Opt-Rheometer was used to evaluate the stretchability.

3. Results and Discussion

3-1 Elastic Recovery Non-Woven Fabrics

1) Spinnability of high elastic recovery spunbond non-woven fabrics

Addition of a small amount of high tacticity polypropylene to LMPP as crystallinity control agent gave high recoverable and non-sticky spunbond non-woven fabrics[1)].

In case of LMPP 100%, as the web was easy to stick to an emboss roll, it was hard to produce non-woven fabrics. But bi-component structure of LMPP 100% as core layer and LMPP blended with a small amount of iso-PP as the sheath layer gave stable continuous production.

The multi-layered non-woven fabrics composed of blend of iso-PP to LMPP as outer layers and 100% LMPP as an inner layer was produced at high speed 400m/min.

2) Elastic Recovery Data[1),2)]

Fig.1 shows the load-strain hysteresis in MD and TD for multilayer non-woven fabrics. 1st load-strain shows not only elastic deformation, but also plastic deformation, so upcurved line was shown. The second load-strain curve shows downcurved line which means elastic deformation was mainly dominated. The stress level in MD was much larger than that in TD and shows anisotropy. This result comes from high line speed. As each fiber was oriented to belt conveyer line direction, the fiber orientation increases with increasing the line speed.

Fig.2 shows the dependence of elastic recovery on the contents of polypropylene for monolayer, multilayer and BICO non-woven fabrics produced using Kasen Nozzle and Reicofil4 spunbond machines. The elastic recovery increases with decreasing conventional iso-polypropylene. It is considered that the crystal phase which causes plastic deformation decreases. As the bicomponent structure composed of only a small amount of high tacticity polypropylene included in the sheath layer and 100% LMPP in the core layer could reduce the total high tacticity polypropylene, high elastic recovery was obtained.

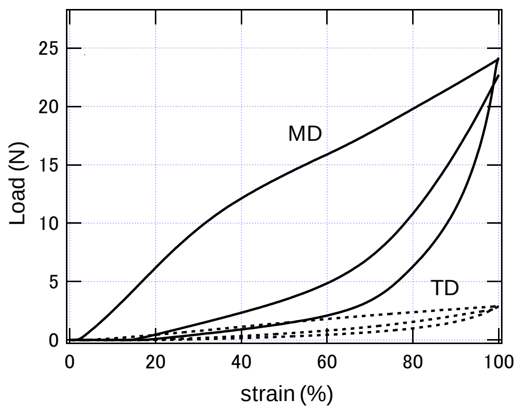

Figure 1. Load-strain hysteresis in MD (solid line) and TD (broken line) for multilayer nonwoven fabric (SMS).

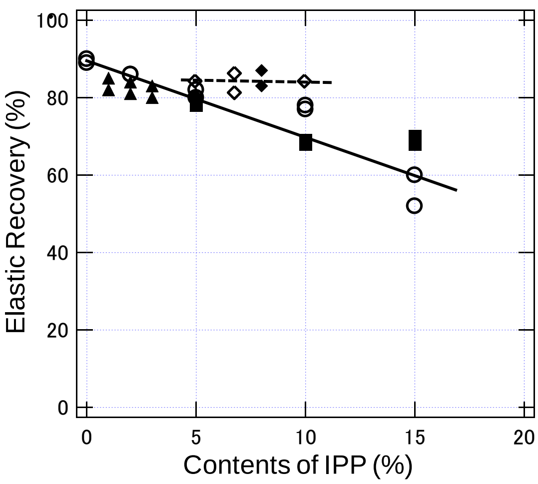

Figure 2. Dependence of elastic recovery on the contents of IPP for monolayer, multilayer and BICO nonwoven fabrics produced using KASEN NOZZULE and REICOFIL4 spunbond

3-2 Improvement of spunbond spinnability

Addition of 10% LMPP to high tacticity PP improved maximum spinning speed from 5km/min to 9km/min[3]. In application to spunbond process, the soft touch spunbond non-woven fabrics composed of fiber denier 0.85 and low web weight 10g/m2 with good web distribution could be produced without any break at high line speed. The fiber denier was predicted by using the theoretical analysis which could set the process conditions of spunbond process.

3−3 Improvement of PP Film Stretchability

1) Reducing yield value by adding LMPP to high tacticity PP

PP grade for biaxially oriented PP film A (F300SP M_w=37.7×10^4, M_w/M_n=4.3, [mmmm]=90.0mol%) and high tacticity polypropylene B (F300SV; M_w=31.8×10^4, M_w/M_n=3.9, [mmmm]=97.7mol%) and 10wt% added low tacticity polypropylene to B (L4-10 were extruded by T-Die and formed 300μm thickness sheet and stretched uniaxially at 140℃.

The stress and strain curves for the blend of LMPP in the conventional PP are shown in Fig.3. The blending of very low tacticity PP decreases the yield value of stress and a higher blending ratio causes a reduction in the yield stress by more than 30%. The blending of low tacticity PP in F-300SP may reduce the crystallization speed, which decreases crystallinity.

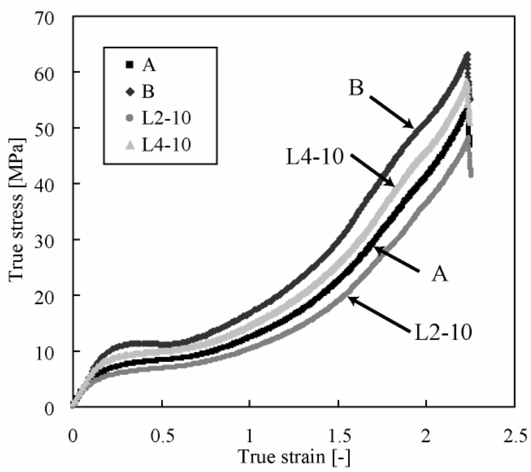

Figure 3.Stress-Strain curve of PP and PP/LMPP Blends

Adding the small amount of very low tacticity polypropylene (LMPP) to high tacticity polypropylene can improve stretchability and thickness uniformity, because the crystallization speed can be controlled by using LMPP which has slow crystallization speed.

As a result, blending of very low tacticity PP to BOPP influenced spherulite size and lamella thickness and decreased the yield stress of stretching force and the stress at the high stretching strain without reducing melt temperature which improves film thickness uniformity and prevents film break during the stretching process (Fig.4).

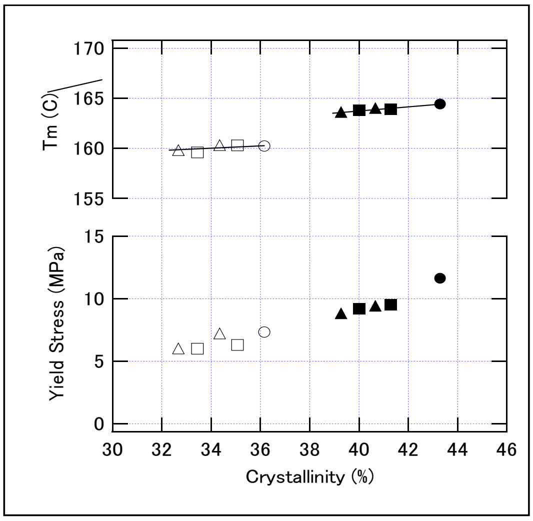

Figure 4. (a)Yield Stresses and Crystallinities of 5% or 10% Blends(■,▲) , (□,△) of Various Different Molecular Weight LMPP (L1:4.3×10^5, L2:4.5×10^4, L3:7.0×10^4, L4:1.1×10^5) to BOPP A (●) and High Tacticity PP(○), (b)Melting Temperature and Crystallinity of Blends

Fig.4(a) shows yield Stresses and crystallinities of 5% or 10% blendsb of various different molecular weight LMPP to BOPP A and high tacticity PP. It was found that yield stress is proportional to crystallinity. 4(b) shows melting temperature is almost constant and does not depend on crystallinity of blends.

4. Reference

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