열가소성 폴리우레탄과 가소화된 폴리비닐 클로라이드 블렌드의 특성

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Properties of Original Thermoplastic Polyurethane (TPU)/ Plasticized Poly(vinyl chloride) (PVC) and Recycling TPU/PVC Blends

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1. Introduction

Blending is an easy and popular means to achieve a desired set of characteristic properties. The blends, by melt mixing of thermoplastic materials and elastomer, have received considerable attention in recent years. It is well known that nearly all blends comprise one polymer domain dispersed in the matrices of the other polymer [1].

Thermoplastic polyurethane (TPU) is one of the most versatile engineering thermoplastics with elastomeric properties. They can be processed, shaped and formed upon heating via numerous industrial processes. Also the TPU possess higher tensile modulus in comparision to rubber, high abrasion resistance, and resistance to oil and many solvents. TPU exhibit excellent properties, including abrasion resistance ; however, because these polymers are not chemically cross-linked, TPU can have a wide rang of chemical structures, because various monomeric materials are now commercially available. Because tailor-made structures appropriate of blending can be obtained by combining various monomeric materials. TPU are expected to show practical promise in polymer blends[2]. The good compatibility of TPU with polar thermoplastics has opened the door to use TPU as a modifier to create new blends.

PVC has been the focus of attention in many such studies is not surprising because of the commercial demand for permanent plasticizers, process aids, impact modifiers, and heat distortion builders for this commodity resin. Also, PVC proves to form a uniquely large number of miscible polymer blends. The blends of PVC and other polymers have been extensively studied for their commercial importance. [3-4] The advantages of PVC include cost and flame resistance-the presence of chlorine in large quantities in the polymer renders it flame retardant. This property of PVC can effectively reinforce lack of flame retardancy of TPU, because TPU are burnable as many organic materials, but, in many application fields flame retardance is required. An important disadvantage of PVC is limited thermal stability, therfore, improvement of thermal stability is required by blending.

In this work, morphology, the thermal, and dynamic mechanical properties of blends of original TPU/plasticized PVC and recycling TPU/plasticizerd PVC were studied to investigate miscibility of the blends according composition vaniation.

2. Experimental

2.1 Materials

TPU(5195A) was supplied by Hosung Chemical Co. and PVC was obtained from Han Wha L&C Corp..

2.2 Preparation

The TPU was dried under vacuum for 24h at 100° C before processing. PVC lacks thermal stability at a processing temperature condition ; thus, prepowder mixing with additives such as a thermal stabilizer was necessary. The plasticized PVC compounds were formulated with the following ingredients before blendning : 50phr di-iso nonyl phthalate as a plasticizer, 2phr thermal stabilizer(KBz 260G), 0.3phr thermal stabilizer(IR-1076), and 3phr polymeric processing aid (E-700). Blends were prepared by melt mixing using Haake Rheocord-90 for 10min with 40 rpm at 190℃. The composition of original TPU/PVC and recycling TPU/PVC blends is shown in Table 1.

2.3 Characterization

Thermal properties were examined using Differential Scanning Calorimeter (DSC, SSS/5200H, MII, Seiko) in the temperature range from 80℃ to 250℃at heating rate of 10C/min. in the presence of a nitrogen atmosphere. The measurement of thermo stabilities were performed on Thermal Gravity Analysis using TG 2950, (TA company) in the temperature range of 25℃-600℃ at a heating rate of 10℃/min in the presence of a nitrogen atmosphere. Dynamic mechanical properties were measured at 3Hz using DMTA MkII (Rheometrics Scientific) with the heating rate of 3℃ /min. over the temperature rang of 80℃ to 150℃. Strain-stress measurement was made in a simple extension on dumbbell specimens using a tensile tester (Tensilon AGS 500D, Simazu) at a cross-head speed of 20mm/min. The morphology of the blends was observed with Scanning Electron Microscope(SEM).

3. Results and Discussion

The sample designation and blend ratio and DSC results for TPU/PVC blend samples are summarized in Table 1. The melting temperature (Tm) of original and recycling TPU were appeared at 166℃ and 178℃, respectively. Tm and △Hm was slightly decreased with increasing PVC content. From the results, it was found that the crystalline region of TPU was destroyed a little by invading of PVC into TPU for TPU/PVC blends. Loss moduli and loss factor (Tan δ) vs. temperature for TPU/PVC blends are shown in Figure 1. Two loss modulus (Tan δ) peak for TPU are observed owing to the glass transition of soft segments (Tgs) and the glass transition temperature of hard segments (Tgh). As the PVC content increased, Tgs of blends increased, however, Tgh of blends decreased. The storage modulus (E') and tensile strength of blend samples were also found to depend on the blend ratio.

From these results, it was concluded that the blends of original TPU/plasticized PVC and recycling TPU/plasticized PVC prepared in this study were partial miscible system..

4. References

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Table 1. Sample designation, blend ratio, and DSC data for TPU/PVC series sample

Designation	Blend ratio (%) TPU / PVC	Melting peak Tm	ΔHm
O-T[1] / PVC (100/0)	100 / 0	166.0	15.9
O-T / PVC (90/10)	90 / 10	164.2	9.2
O-T / PVC (75/25)	75 / 25	163.0	8.7
O-T / PVC (50/50)	50 / 50	160.0	5.9
O-T / PVC (0/100)	0 / 100	158.1	2.1
R-T[2] / PVC (100/0)	100 / 0	173.1	20.7
R-T / PVC (90/10)	90 / 10	171.0	9.8
R-T / PVC (75/25)	75 / 25	169.0	7.7
R-T / PVC (50/50)	50 / 50	166.7	6.1
R-T / PVC (0/100)	0 / 100	158.1	2.1

1) Original thermoplastic polyurethane.

2) Recycling hermoplastic polyurethane

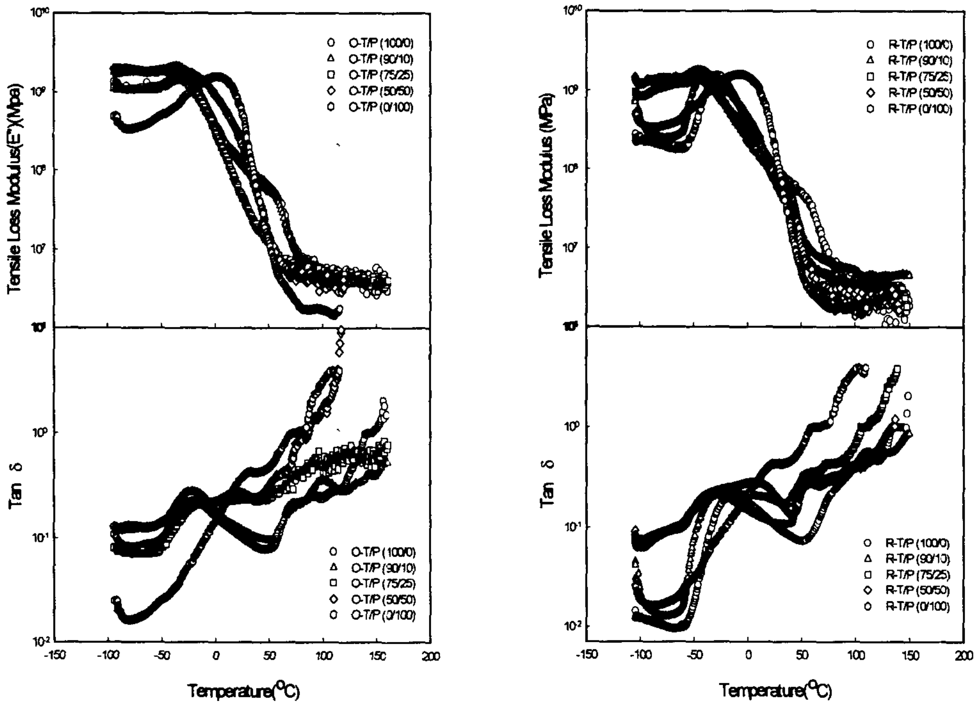

Figure 1. Tensile loss modulus and Tan δ vs. temperature for TPU/PVC series sample.