



HDPE/TPS

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Mechanical Properties and Biodegradability of HDPE/TPS Blends

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: 가 (TPS) , TPS
(HDPE) . , ,
(ISO14855) . TPS
가 , HDPE/TPS T_m 가 , TPS 가
. 45 TPS 가 가 가 .

ABSTRACT : Thermoplastic starch(TPS) was prepared from mixing starch and glycerol by twin extruder. The blends were then prepared from high density polyethylene(HDPE) and TPS. Mechanical properties, thermal properties, and morphology of the blends were investigated. Their biodegradability was also studied by using aerobic composting method(ISO14855). Tensile strength, modulus and elongation at break decreased as the content of TPS increased. In particular elongation at break decreased rapidly even at the lower content of TPS. The melting temperatures of the blends were not changed, which showed that HDPE and TPS were immiscible. The morphology of the fractured surface of blend films was investigated by scanning electron microscopy(SEM). It was found that phases were separated. After composting for 45days, the biodegradability of the blends increased as the content of TPS increased.

Keywords : thermoplastic starch, biodegradability, morphology, composting, mechanical properties.

.1 가 ,
, 가 , .
가 , 가 ,
가 1 , ,
가 .2,3

가 , 100 , 15 kg/hr
 가 , TPS 가
 가 starch/glycerol (80/20) 가
 TPS
 HDPE (7000F) ()
 가 가 TPS
 , 가 20% 가 HDPE/TPS (: 90/10, 80/20, 70/30,
 .⁴ 가 가 60/40, 50/50, 40/60)
 가 . 90, 110, 140, 150,
 가 가 140, 100 ,
 .⁵⁻⁸ 가 가 가 6 1 kg 가
 가 .
 .⁹⁻¹¹ 가 가 (50×120×0.2 mm) 가 (170 ,
 가 가 가 10000 kPa) 3 , 1 가
 가
 .¹²⁻¹⁴ 가
 가 thermoplastic starch(TPS) twin screw extruder , high density polyethylene (HDPE) HDPE/TPS
 , morphology
 .^{15,16} 30%
 .
 . TPS
 () ,
 48 2%
 (Junsei Chemical Co.)
 . TPS 46.2
 mm screw L /D=30/1 가
 (S.M Co TEK 45)
 TPS , 가 ,
 가 가 .
 가
 (T₁ - T₆) 100, 130, 140, 150, 130,

100 , 15 kg/hr
 , TPS 가
 starch/glycerol (80/20) 가
 TPS
 HDPE (7000F) ()
 TPS
 HDPE/TPS (: 90/10, 80/20, 70/30,
 60/40, 50/50, 40/60)
 90, 110, 140, 150,
 140, 100 ,
 가
 6 1 kg 가
 가 (170 ,
 가
 3 , 1 가
 (KS 2)
 Testometric
 (material testing machine, MICRO 350)
 50 mm/min 6
 TA Instruments
 (differential scanning calorimeter,
 TA4000/Auto DSC 2910 System)
 100 200 가
 1st run
 100
 2nd run , 20 /min
 Polymer Laboratories TGA (thermogravimetric
 analyzer, TGA - 1500)
 20 /min
 600

HDPE/TPS

HDPE/TPS
20
(scanning electron microscopy,
HITACHI S-4100)
ISO 14855
16,17
18 45
8
CO₂ 5 (1
cm x 1 cm), blank,
(Sigmacell, Sigma, TLC grade, particle
size < 2 μm) 3
(60%)
300 g
30 g
CO₂
(net) CO₂

$$D_t = \frac{(C)_t - (C)_b}{C_{Th}} \times 100$$

D_t : (%)

(C)_t :

(C)_b : blank

C_{Th} :

(elemental analyzer,

FISONS EA 1108 CHNSO)

TCD detector, range 0.01 - 100%

Table 1

Table 1. Test Materials and Carbon Weights for Experiment

material	weight (g)	carbon weight (g)
cellulose	30	12.85
HDPE	30	25.49
HPT10 (HDPE/TPS = 90/10)	30	24.56
HPT30 (HDPE/TPS = 70/30)	30	21.75
HPT50 (HDPE/TPS = 50/50)	30	19.52
TPS	30	12.57

Table 2. Tensile Properties of HDPE/TPS Blend Films

blends	HDPE	TPS	tensile strength (MPa)	elongation (%)	tensile modulus (MPa)
HDPE	100	0	25	830	220
HPT10	90	10	22	64	183
HPT20	80	20	17	54	164
HPT30	70	30	14	39	131
HPT40	60	40	9	38	93
HPT50	50	50	8	31	104

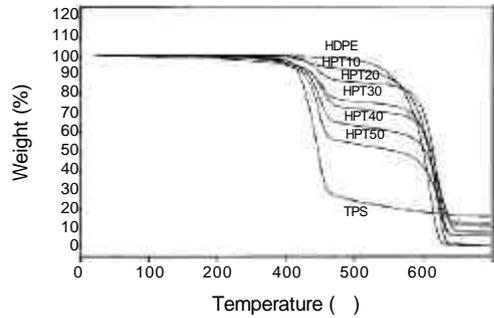


Figure 1. TGA curves of blends prepared by varying HDPE/TPS ratio.

SEM

HDPE/TPS (: 90/10, 80/20, 70/30, 60/40, 50/50, 40/60, 30/70, 20/80, 10/90)
TPS가 60% 가

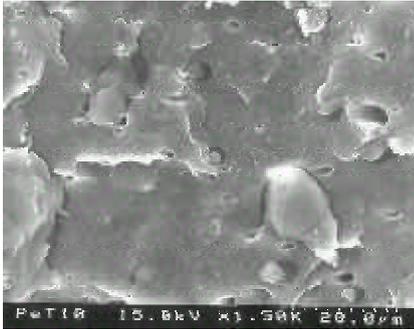
HDPE/TPS

Table 2

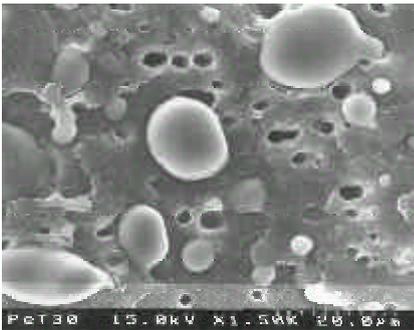
TPS 가
TPS 10% 가 HDPE
90%
가
가
7,19 가

Table 3. Thermal Properties of HDPE/TPS Blends

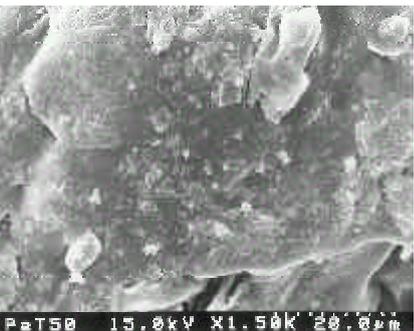
	HDPE	TPS	T_m (°C)	H_f (mcal/mg)
HDPE	100	0	133.2	39.7
HPT10	90	10	135.2	36.4
HPT30	70	30	132.6	38.8
HPT50	50	50	132.4	42.9



(a)



(b)



(c)

Figure 2. Scanning electron micrographs of the fractured surfaces of HDPE/TPS blends. (a) HDPE/TPS (90/10), (b) HDPE/TPS (70/30), and (c) HDPE/TPS (50/50).

가 HDPE

Figure 1

305 , HDPE 440

TGA

가

. TPS

.²

가

TPS HDPE

가

Table 3

가

TPS

(T_g)

TPS T_g 가

50

.¹⁰

TPS

가

(T_m)가

, HDPE

T_m 133

T_m

가

가

, TPS

HDPE

Figure 2

. DSC

HDPE/TPS

가

. HDPE/TPS

(90/10)

HDPE/TPS(70/30)

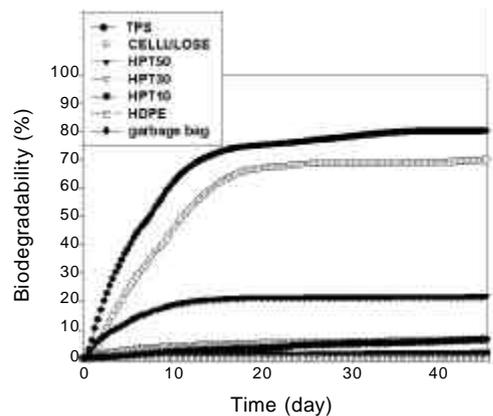
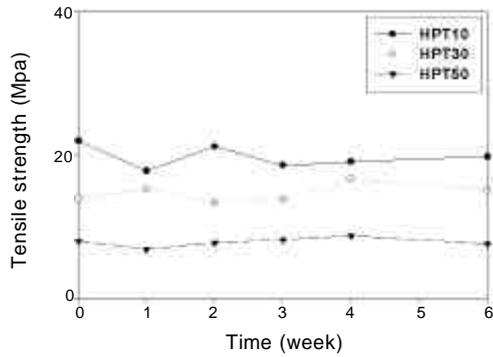
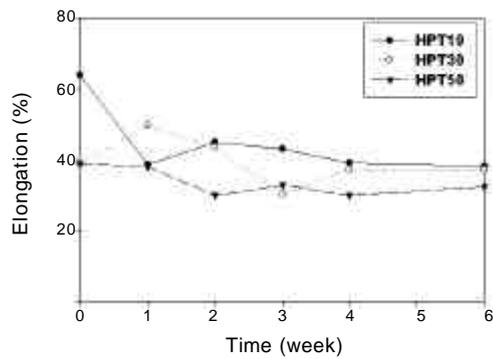


Figure 3. Biodegradation of films under controlled aerobic composting conditions.

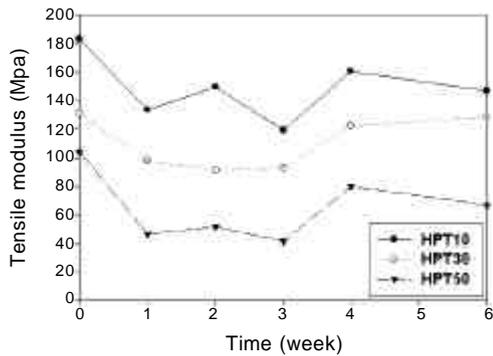
HDPE/TPS



(a)



(b)



(c)

Figure 4. Change in the tensile properties of HDPE/TPS blends during biodegradation test. (a) tensile strength, (b) elongation, and (c) tensile modulus.

HDPE가 TPS
HDPE/TPS (50/50) 가
2 .



(a)



(b)

Figure 5. Scanning electron micrographs of the surface of HDPE/TPS (50/50) film. (a) before and (b) after biodegradation test.

Figure 3

45
가 70%,
가 1.67, blank
1 g 99 mg
HDPE, HPT10, HPT30,
HPT50, TPS 0, 2, 7, 22,
80% HDPE
가 , TPS가 30% 가
HPT30 가 7%가
HDPE가 TPS
가 . TPS
가 가 HPT50 가 SEM
2 가 22%
TPS , HDPE TPS 80%
HPT50 22%

Figure 4
 (30%)
 6.6% HDPE/TPS (70/30)
 90% 가

가 50% 가 2
 가 .
 TPS, HPT50, HPT30, HPT10, HDPE
 , TPS 가 가
 가 . HDPE
 가 , TPS가 30% 가 HPT30
 가 7%가
 HDPE가 TPS
 가 . HPT50
 (22%) 2
 TPS가
 SEM

HDPE가 TPS
 HPT10 HPT30
 가 HPT50
 Figure 5
 HDPE TPS
 가
 TPS
 starch/glycerol(80/20) 가
 TPS
 가 60% 가
 가
 TPS가 10% 가
 TPS
 TGA
 가
 (T_m)가
 HDPE()
 TPS()
 , TPS

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HDPE/TPS

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