

Nylon6

PP/PS

(2001. 7. 23, 2001. 11. 22)

A Study on the PP/PS Blends with Nylon 6 Reactive Compatibilizers

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(Received July 23, 2001; accepted November 22, 2001)

RPP(maleic - anhydride grafted polypropylene) OPS(oxazoline grafted polystyrene)
RPP OPS Nylon6
가 . RPP, Nylon6, OPS , FT - IR, DSC . 3
RPP/Nylon6/OPS가 . RPP/Nylon6/OPS
RPP OPS가 1:1 Nylon6 가 0.66 , Nylon6
가 1 . RPP/Nylon6/OPS
가 Nylon6 가 1.5
가 RPP/Nylon6/OPS 3 PP/PS
가 PP/Nylon6/PS
RPP/Nylon6/OPS가 PP PS

ABSTRACT : RPP(maleic - anhydride grafted PP)and OPS(oxazoline grafted PS) do not react to each other, and thus show immiscibility. In this study, Nylon6 was added to RPP/OPS blend systems, as a reactive compatibilizer for enhancing the miscibility of the blends. When Nylon6 was added to the blends of RPP and OPS, RPP/Nylon6/OPS was produced. The effects of the molar ratio of Nylon6 on the RPP - Nylon6 - OPS reaction were studied. Torque test and FT - IR analysis have been carried out to investigate the reaction of RPP/Nylon6/OPS system. The reaction torque ratio and reaction efficiency show the maximum values at 1 : 0.66 : 1 and 1 : 1 : 1 (in moles) for RPP/Nylon6/OPS. In the RPP/Nylon6/OPS blends, their mechanical properties were changed with the molar ratio of Nylon6 and showed the highest value at molar ratio of 1.5. Physical properties and compatibility of RPP/Nylon6/OPS were compared with those of PP/Nylon6/PS. Consequently, RPP/Nylon6/OPS plays a proper role as a reactive compatibilizer to the PP/PS blend system.

Keywords : polypropylene, polystyrene, Nylon6, blend, reactive compatibilizer.

carboxyl acid
RPP OPS 가
가
, RPP, OPS, Nylon6 3
RPP/Nylon6/OPS
, 3
가 Nylon6
1-4 (PS)
가
(scratch)
(PE),
(PP) 가
가
가
가
5-20
가
(SEBS)
21
(reactive
extrusion)
15-26 Hohfeld
(LLDPE) acid - function -
alized PE oxazoline - functionalized PS
4
27, Yamamoto
28,29
maleic anhydride func -
tionalized PP(RPP) oxazoline functionalized PS(OPS)
가 RPP OPS
가
가
가 RPP maleic anhydride
OPS oxazoline amine

Nylon6
RPP OPS 가
RPP, OPS, Nylon6 3
RPP/Nylon6/OPS
, 3
가 Nylon6
PP/Nylon6/PS
RPP OPS
() OPS
, Nylon6 가
grade TNC - 1011 RPP
OPS , Nylon6
Table 1
RPP/Nylon6/OPS Banbury batch
(Brabender plasticoder) Nylon6
RPP OPS
250 , (rotor) 100 rpm,
10 , 40 g
RPP, Nylon6, OPS
가
Nylon6
Table 2
Nylon6

Table 1. Descriptions of Materials Used in This Study

polymer	abbreviation	number average molecular weight(M _n)	percentage of grafting	melt index (230 , g/10 min)	remark
PP -g- MAH	RPP	16K	5 wt%	1000	solution
PS -g- oxazoline	OPS	70K	5 wt%	14	solution
Nylon6	N6	17K			
polypropylene	PP	60K		3	homo -PP
polystyrene	PS	110K		4	GPPS

Nylon6

Table 2. Descriptions of RPP/Nylon6/OPS Blends (Batch Mixer)

blend	abbreviation	blend composition	
		molar ratio	weight ratio
RPP/Nylon6/O	PNO-0.2	1 : 0.2 : 1	1.5 : 2.4 : 1
PS	PNO-0.33	1 : 0.33 : 1	1.5 : 4 : 1
	PNO-0.66	1 : 0.66 : 1	1.5 : 8 : 1
	PNO-1	1 : 1 : 1	1.5 : 12 : 1
	PNO-1.5	1 : 1.5 : 1	1.5 : 18 : 1
	PNO-2	1 : 2 : 1	1.5 : 24 : 1

OPS가 , RPP MAH(maleic anhydride)
 Nylon6 가 Nylon6
 PP-g-Nylon6 , 가
 OPS (oxazoline) Nylon6
 (carboxyl) 가 PS-g-Nylon6
 OPS (1)
 RPP, Nylon6, OPS 가
 1 : 1 : 1 ,

$$\frac{W_{RPP} \cdot GR_{MAH}}{MW_{MAH}} = \frac{W_{OX} \cdot GR_{OX}}{MW_{OX}} = \frac{W_{N6}}{M_{nN6}} \quad (1)$$

W_{RPP} RPP , GR_{MAH} MAH
 , MW_{MAH} MAH 98
 W_{OX} OPS , GR_{OX} OPS
 , MW_{OX}
 70 W_{N6} Nylon6 , M_{nN6} Nylon6
 RPP/Nylon6/OPS . RPP, Nylon6,
 OPS batch mixer
 FT-IR(Perkin-Elmer 1760x)
 Nylon6 RPP Nylon6, OPS
 , DSC(TA Instruments Co., model TA2100)

(Soxtec Avanti 2050) 3

OPS Xylene ,
 (120) 4

RPP, Nylon6, OPS

PP/PS

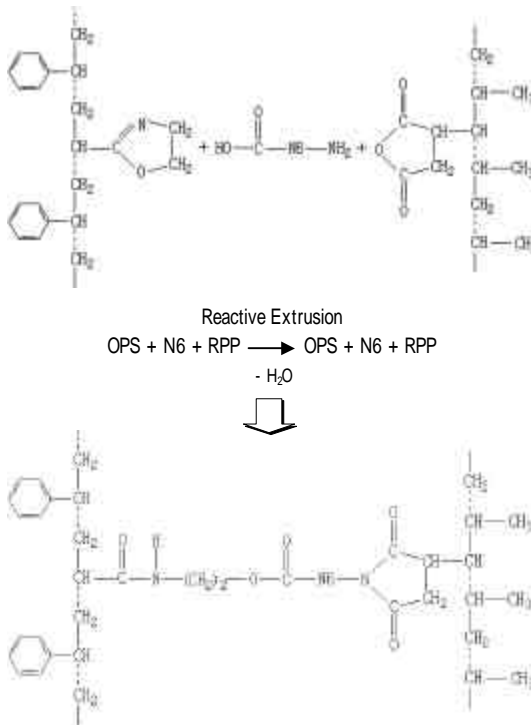


Figure 1. Reaction scheme of RPP, Nylon6 and OPS.

Table 2 twin extruder(L/D=30, corotating type) 240-250-260-260
 100 rpm, 60
 Nylon6

MEK(methyl ethyl ketone) toluene PS
 (SEM)
 PP/PS RPP/Nylon6/OPS 가
 MEK
 PS

FT-IR . FT-IR
 RPP, OPS Nylon6 Figure 2
 . RPP 1860 1780
 cm^{-1} cyclic -COO- MAH

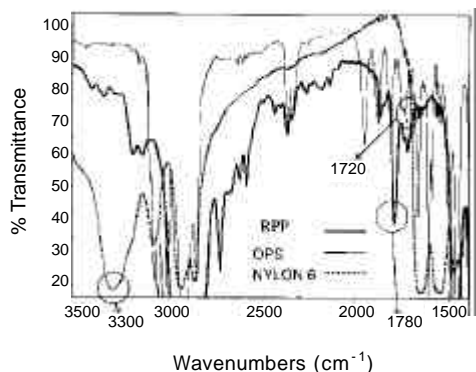


Figure 2. FT - IR spectra of RPP, Nylon6 and OPS.

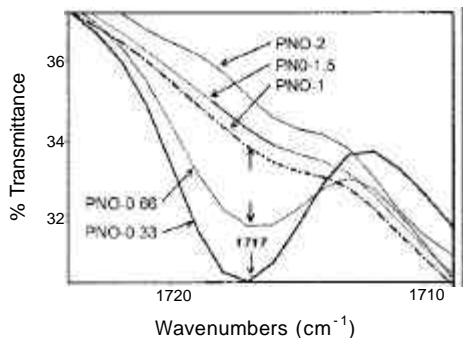


Figure 3. FT - IR spectra of OPS/Nylon6 reaction in RPP/Nylon6/OPS.

diacid 1710 cm⁻¹ noncyclic -COO-
 가 , Nylon6 1780
 cm⁻¹ 가 . OPS
 1723 cm⁻¹ -CO- 1630 cm⁻¹ -C=N-
 . RPP, OPS, Nylon6

Figure 3 4 OPS/Nylon6 RPP/Nylon6

PNO RPP/Nylon6/OPS
 Nylon6 . RPP/Nylon6/OPS
 Nylon6 OPS -CO-
 1717 cm⁻¹가 , Nylon6
 가 가
 (Figure 3). RPP 1780 cm⁻¹

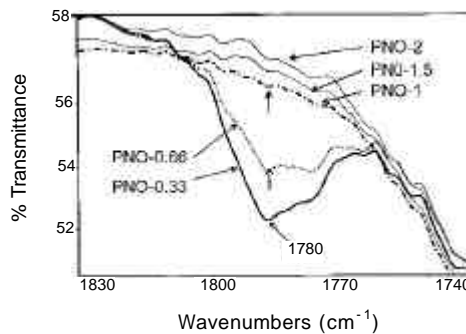


Figure 4. FT - IR spectra of RPP/Nylon6 reaction in RPP/Nylon6/OPS.

cyclic -COO-
 (Figure 4). RPP OPS 가 Nylon6
 가 Nylon6

가 가
 . RPP/OPS(1:1)
 2

RPP/Nylon6/OPS 가. Table

2 RPP OPS
 (1:1) Nylon6
 0.2 2 3

Brabender mixer
 RPP MAH OPS
 Nylon6 3

가 가 가
 가 가 가
 가 가 . Figure 5 Nylon6

- 3
 RPP OPS 5

가 . Figure 5
 (2)
 Nylon6 가 1

$$K = \frac{\text{Nylon 6}}{\text{Nylon 6} \text{ 가 } 1} \quad (2)$$

Nylon6 가 0.66
 가 . Nylon6

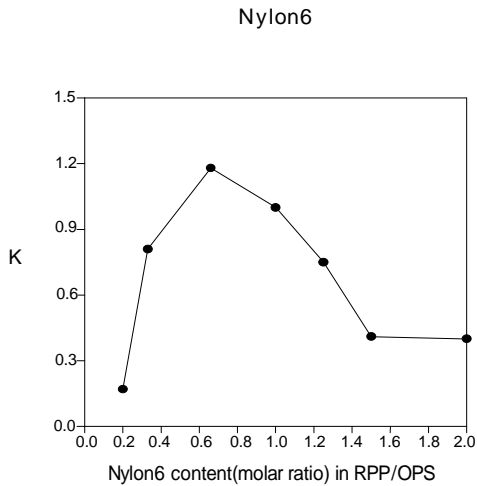


Figure 5. Mixing torque ratio K with Nylon6 content in RPP/OPS.

RPP, OPS가
 RPP - Nylon6 - OPS
 (RPP, Nylon6, OPS)가 가
 Nylon6 가
 RPP OPS
 (RPP+OPS)
 Nylon6 1 (RPP+OPS)
 () Nylon 6
 (RPP+OPS) Nylon6 1
 가 RPP OPS
 Nylon6, 1 가
 RPP/OPS RPP/Nylon6/OPS . 3

Brabender mixer RPP/OPS, RPP/Nylon6,
 OPS/Nylon6 (1:1)

2 OPS toluene
 SEM

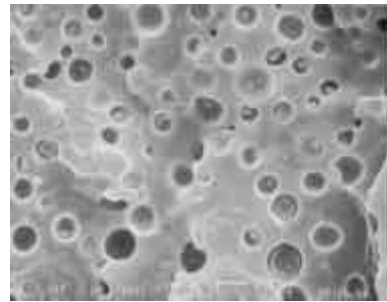
Figure 6 Figure 6 (a)
 RPP/OPS OPS가

가 1 μm
 RPP OPS

Figure 6 (b) RPP/Nylon6
 가 0.2 μm (a)

5 OPS/Nylon6
 (c) 가 0.3 μm

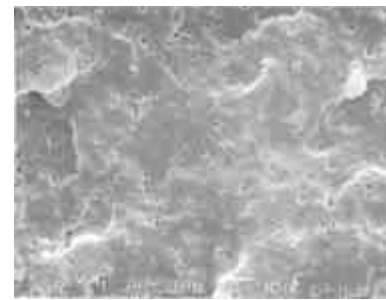
PP/PS



(a) 2 μm



(b) 2 μm



(c) 2 μm

Figure 6. SEM photographs of the etched surfaces of the blends. (a) RPP/OPS(1:1), (b) RPP/Nylon6(1:1), and (c) OPS/Nylon6(1:1).

(a) 3 , (b) (c)

RPP/Nylon6 OPS/Nylon6 가

RPP OPS

가

2

Brabender
 (Soxtec Avanti 2050) xylene

(170) RPP OPS
 Figure 7 Nylon6
 RPP OPS RPP
 OPS
 RPP OPS
 (3)

$$d = \frac{\text{RPP OPS}}{\text{RPP OPS}} \quad (3)$$

RPP/Nylon6/OPS Nylon6
 RPP, OPS
 가 , Nylon6 가

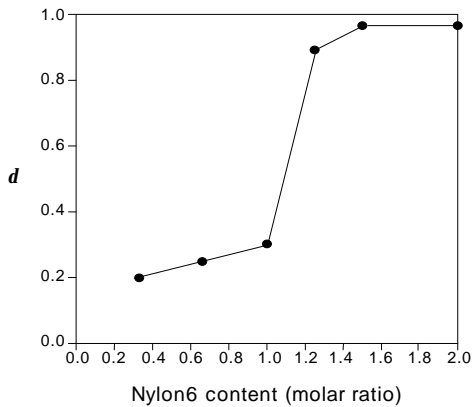


Figure 7. Variation of residual weight ratio() with the Nylon6 content after extraction of unreacted OPS and RPP

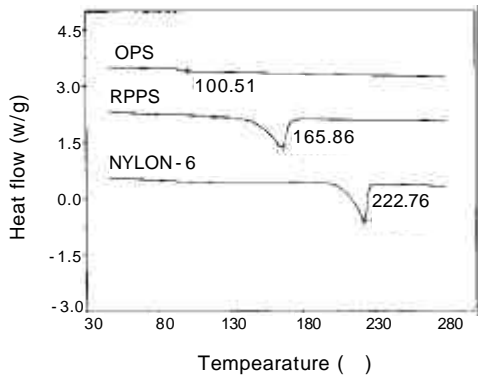


Figure 8. DSC thermograms of RPP, OPS and Nylon 6.

RPP/Nylon6/OPS
 Nylon6 1.5

Figure 7 Nylon 가 가
 가 RPP OPS
 가 Nylon6 가 1.5
 RPP OPS가

Table 2
 Brabender mixer 3
 3

(Figure 8) (Figure 9)
 (Figure 10),
 (Figure 11)

3 (- -)

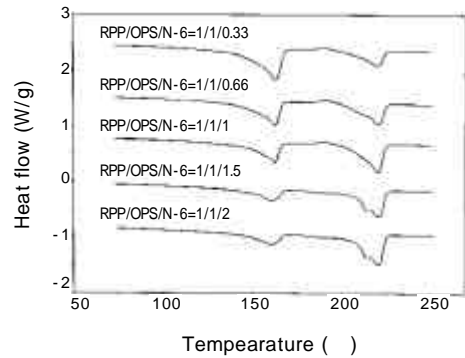


Figure 9. DSC thermograms of the RPP/OPS blends with different content of Nylon 6.

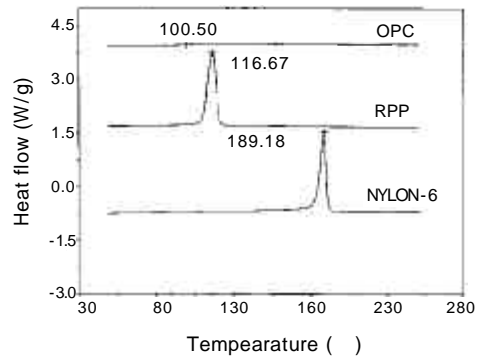


Figure 10. DSC cooling thermograms of RPP, OPS and Nylon6.

Nylon6

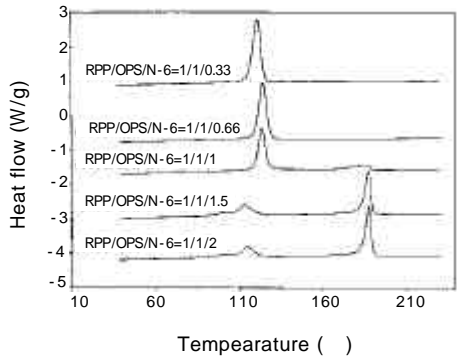


Figure 11. DSC cooling thermograms of the RPP/OPS blends with different content of Nylon6.

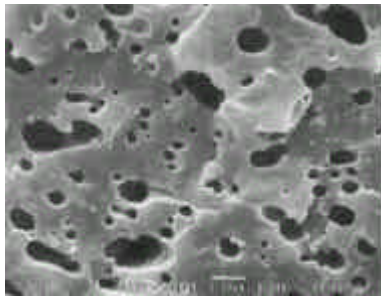
PP/PS

Table 3. Physical Properties of RPP/Nylon6/OPS and PP/Nylon6/PS Blends

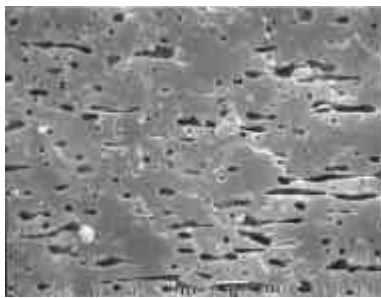
blend	molar ratio of Nylon6	tensile strength [kg/cm ²]	elongation [%]	flexural modulus [kg/cm ²]
RPP/Nylon6/OPS	0.6	430	41	21000
	1	560	150	24000
	1.5	620	260	25000
	2	630	280	26000
	0.6	440	4	20000
PP/Nylon6/PS	1	490	10	21000
	1.5	580	10	23000
	2	610	11	24000

(T_m) (T_c)
 (Figure 9) Nylon6 가 1
 Nylon6 가 2
 5
 Nylon6 1 Nylon6
 가 RPP, OPS, Nylon6
 가 Nylon6
 Figure 11
 Nylon6 가 1 T_c가
 , Nylon6 가 1 T_c가
 Nylon6 T_c PP T_c
 . Nylon6 0.66
 Nylon6 가 50%
 가 RPP - Nylon6 - OPS
 . Nylon6
 1 Nylon6 T_c 가 , Nylon6
 Nylon6 T_c
 . Nylon6 가 1 T_c
 가 , Nylon6 T_c PP T_c
 RPP, OPS, Nylon6
 concurrent crystallization
 T_c가 PP T_c
 . concurrent crystalli-
 zation Nylon6 가
 .³⁰
 PP/Nylon6/PS RPP/Nylon6/OPS

. RPP/Nylon6/OPS
 Nylon6
 PP/Nylon6/PS . Table
 3 Nylon6 , ,
 (notched izod impact strength)
 . Table 3 Nylon6 가 가
 RPP/Nylon6/OPS
 가 , 가 . Nylon6
 PP/Nylon6/PS
 1 RPP/Nylon6/OPS
 , Nylon6 0.5 10 ,
 1.5 26 PP/Nylon6/PS
 RPP/Nylon6/OPS 26
 가 . Nylon6 가
 가
 Nylon6
 Nylon6 Nylon6
 가
 PP/PS PP/RPP/Nylon6/OPS/PS
 . 3 (RPP/Nylon6/
 OPS 1:1:1) PP/PS
 PP/PS 가
 . PP PS 70/30 3
 10 wt% 가
 . Figure 12
 MEK PS SEM
 . PP/PS
 가 3 μm , 3
 가 10 wt% 가 PP/RPP/Nylon6/OPS/PS



(a) 10 μm



(b) 10 μm

Figure 12. SEM photographs of the etched surfaces for the PP/PS 70/30 blends containing RPP/Nylon6/OPS. (a) PP/PS(70/30) and (b) PP/PS(70/30) containing RPP/Nylon6/OPS(10 wt%).

가 1.2 μm
RPP/Nylon6/OPS가 PP PS
PP/PS 가
RPP/OPS
Nylon6 가 RPP/Nylon6/OPS
3 RPP/Nylon6/
OPS , FT - IR
PP/PS 가
1. Nylon6 가 RPP
OPS FT - IR RPP/Nylon6 OPS/
Nylon6 , RPP/OPS/Nylon6

Nylon6 1.5 3
가 ..
2. RPP/Nylon6/OPS Nylon6
가 0.66 가 가
Nylon6 1 Nylon6 가
3
3. Nylon6 가
, Nylon6가 RPP/OPS
4. RPP/Nylon6/OPS 가 PP/Nylon6/PS
, Nylon6
가 1.5
5. PP/PS RPP/Nylon6/OPS 3
가 PS 가
RPP/Nylon6/OPS가 PP/PS

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