Solid-state Extrusion of Recycled Poly(ethylene terephthalate)/Maleated Linear Low-density Polyethylene Blends

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Abstract: Several R-PET/LLDPE blends were prepared by low-temperature solid-state extrusion. Effect of LLDPE-g-MA on properties of the blends was discussed systematically. Elongation at break of R-PET was improved effectually when the LLDPE-g-MA content was 10%. LLDPE-g-MA great effected crystallization behavior of PET in this blending system. Crystallinity of PET was decreased with the increasing of LLDPE-g-MA content. SEM results show LLDPE-g-MA dispersed very well in PET matrix.

Key words: recycled PET; LLDPE-g-MA; crystallization behavior; tensile properties
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Conventional recycling methods can't recover R-PET properties effectively. It is necessary to develop new recycling method. Literatures[1-4] indicate that blending of PET with polyolefins and/or elastomers can improve properties of PET. In this research, LLDPE-g-MA was used to modify R-PET by solid-state extrusion.

1 Experimental

1.1 Materials

Scraps of recycled PET were from Zijiang Bottle Ltd. (Shanghai, China) with an intrinsic viscosity of 0.71 dL/g. LLDPE-g-MA with 1% maleic anhydride was homemade.

1.2 Characterization

According to Chinese Standard GB/T1040—1992, tensile properties were tested. DSC was performed on NETZSCH DSC PC 200 (German). Temperature range was 280~70℃ with a nitrogen atmosphere, samples (7mg~10mg) were heated with a cooling rate of 10℃/min. Crystallization temperature, T_c, was determined as corresponding to the maximum of the exothermic curve. Morphology of the blends was revealed by means of a Scanning Electron Microscopy (SEM) instrument (JSM 6100). Samples were fractured after freezing in liquid nitrogen and coated with gold before testing.

2 Results and discussion

2.1 Tensile properties

Figure 1 shows the effect of LLDPE-g-MA content on tensile properties of blends. Addition of 10% LLDPE-g-MA increased the elongation at break from 126.0% to 352.8%. Further increasing LLDPE-g-MA content, terminal elongation of blends change slightly, while yield stress of blends decrease continuously.

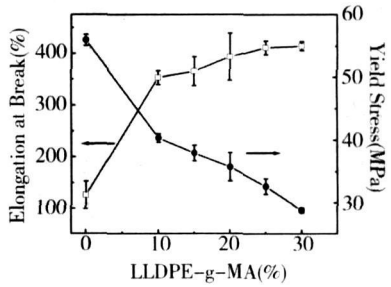

Figure 1 The effect of LLDPE-g-MA content on tensile properties of blends

2.2 Crystallization behavior

The crystallization temperature (T_c), crystallinity and half crystallization time ($t_{1/2}$) of PET are listed in table 1. The crystallization temperature (T_c) for RET in R-PET/LLDPE-g-MA blends are higher than that of

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virgin recycled PET. The ΔTc's for PET in blends are narrower by 12.6℃ to 15.0℃ than that of virgin recycled PET (25.8℃). The Half crystallization time ($t_{1/2}$) of PET in blends is also less than virgin R-PET. This indicates that LLDPE-g-MA can act as nucleation agent for PET. Crystallinity of PET decreased with the increasing of LLDPE-g-MA content when its content was over 15 wt%.

Table 1 Thermal properties of R-PET and R-PET/LLDPE-g-MA blends during cooling scanning

R-PET/LLDPE-g-MA	Tc/℃	ΔTc/℃	$t_{1/2}$/s	Crystallinity/%
100/0	158.6	37.8	25.8	—
90/10	191.6	17.8	10.8	26.94
85/15	195.3	16.5	10.2	29.02
80/20	188.4	24.4	12.0	26.59
75/25	192.0	19.4	11.4	26.02
70/30	188.7	21.2	13.2	25.63

2.3 Morphology

In figure 2 LLDPE-g-MA particles dispersed in PET matrix finer. Increasing LLDPE-g-MA content, the morphology of LLDPE changed from spherule to cigar bar, then to irregular spherule. Perhaps, it means that it is immiscible between PET and LLDPE-g-MA. PET-co-LLDPE-g-MA copolymer, which was produced by malecic anhydride group reacting with end hydroxyl group of PET, acts as compatibilizer to improve their compatibility.

3 Conclusions

The addition of 10% LLDPE-g-MA can effectively improve elongation at break of R-PET. Thermal analysis shows that LLDPE-g-MA has great effect on crystallization behavior of PET. Crystallinity of PET in blend is higher than that of in virgin R-PET. However, crystallinity of PET in blends is decreasing with the increasing of LLDPE-g-MA content. LLDPE-g-MA and PET are immiscible and PET-co-LLDPE-g-MA can act as compatibilizer to improve their compatibility.

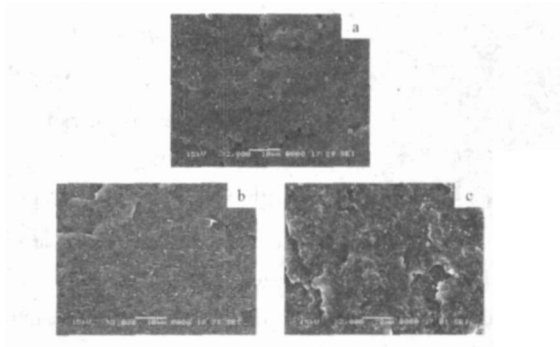

Figure 2 SEM micrographs of R-PET/LLDPE-g-MA (a) 90/10, (b) 80/20, (c) 70/30

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LLDPE-g-MA改性 R-PET的研究

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摘 要: 采用低温固相挤出工艺制备了 R-PET/LLDPE合金, 并对 LLDPE-g-MA用量对合金的性能的影响进行了系统的讨论。结果表明添加 10%的 LLDPE-g-MA就可以明显改善回收 PET的断裂伸长率, 继续增加 LLDPE的用量, 合金的断裂伸长率并没有进一步提高, 但 PET的结晶度随着 LLDPE-g-MA用量的增加而呈下降趋势。SEM图表明, LLDPE-g-MA在 PET基体中分散得很均匀。

关键词: R-PET; LLDPE-g-MA; 结晶行为; 拉伸性能

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