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Evaluation of Recycled Far-infrared/Impact-Resistant Poly(propylene) Composite Plates

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Abstract.

In recent year, the environmental consciousness is awakening; hence, the plastic recycling and reusing techniques have drawn much attention. In this paper, impact-resistant polypropylene(IRPP) chips were mixed with nano far-infrared master batches polypropylene(NFMPP) chips in different weight ratios. Then the polypropylene composite plates were formed by using a single screw extruder. Afterward, this study also simulated the plastics recycling procedure from 1 to 6 times, respectively. The results shown the average far-infrared emissivity of polypropylene composite plates were 0.90±0.02ε. In the IZOD measurement, the impact strength of polypropylene composite plate which processed for six times dropped by 20% comparing to the composite plate processed only once.

1.Introduction

Fiber, plastic and rubber are widely used in daily life, especially the rapidly developing petrochemical industry. They are part of artificial polymers, which are hard to decompose; therefore, man-made polymers are effectively reused to minimize environmental destruction. (1)

The recycled waste polymers have many problems, but thermoplastic polymer is recyclable in the chemical industry. The thermoplastic polymer is composed of linear chain polymer or branched chain polymer , which could be melted, cooled, and then hardened repeatedly. With this property, the thermoplastic polymer is recyclable. However, polymer's degree of degradation subjects to temperature, shear force and friction lie in repeatedly melt and cooling. The polymer degrades gradually during the melting, cooling and hardening procedure because of heat, shear force, and abrasion. This degradation not only crisps and weakens the final product's mechanical property, but also shadowed its look, accompanied by visible superficial defects.

Degradation is harmful to quality [2,3]. Polypropylene (PP) has been used in various applications in daily life owing to its low density, excellent thermal property, physical property and good process ability with its appropriate price. (4)

2.Materials and methods

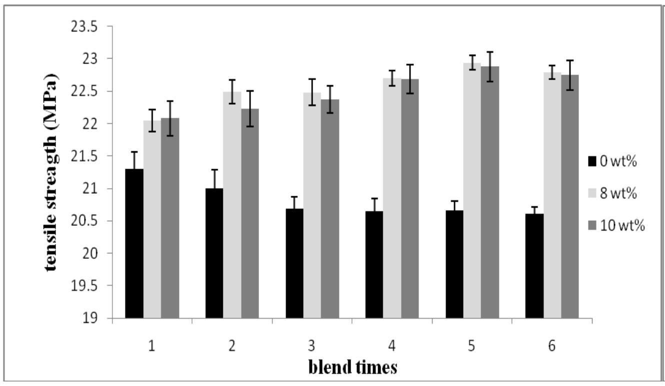
Impact-resistant polypropylene (IRPP) chips: Formosa chemicals fiber corporation (grade:K8003) with the melt flow index (MFI) at 3 g/10 min.

Nano far-infrared master batches polypropylene (NFMPP) chips: hau mao nano-tech(grade: TAN AP 9008)with the melt flow index(MFI) at 106 g/ 10 min. NFMPP accounted for 20 wt% of the powder, Al_20_3, ZnO_2, and ZrO_2 ; the powder's diameter was 500 μm.

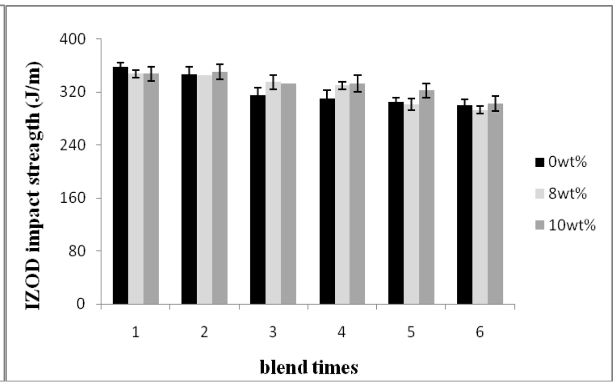
In this study , we blended difference weight ratios of ICPP chips and NFMP chips(0 , 8 , and 10 wt%) and cut them into granulates by the single screw extrusion. The mixture was placed into the single-screw extrusion to be melt and blended. The extruded mixture was spewed out into cool water to be formed into granulates. The barrel temperatures were each set at 210 ℃, 220 ℃ and 230 ℃; the die temperature was set at 240 ℃; the screw speed was 20 rpm. The granulates were dried at 60 ℃ for 4 hours before they were re-processed in the single-screw extrusion. Then the aforementioned procedure started again. Six specimens of each parameter was tested. Finally, the granulates were dried at 60 ℃ for 4 hr. The above compositions were subjected to injection molding using an injection molder at a cylinder temperature at 230 ℃.

This experiment had the final product's physical property and emissivity evaluation, including tensile strength, IZOD impact strength, flexural strength and far infrared ray emissivity tested. Tensile strength test was according to ASTM-D63. The IZOD impact strength test was according to ASTM-D256. Flexural strength test was according to ASTM-D2240. Far infrared ray emissivity test was according to FTTS-FA-010.

3. Results and discussion



(a)



(b)

(a) Figure. 1 The tensile strength of impact-resistant polypropylene and nano far-infrared master batches polypropylene (0, 8, and 10 wt%)
The composite plates were processed from one to six times.

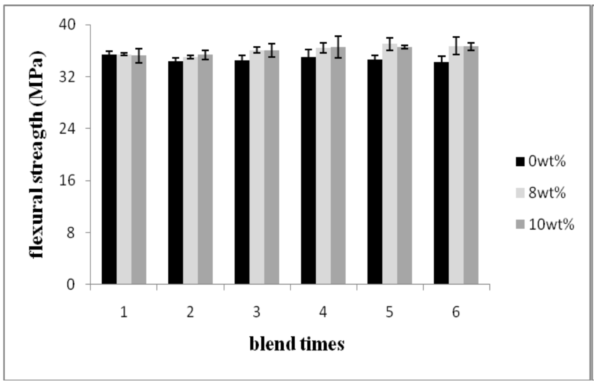
(b) Figure. 2 The Izod impact strength of impact-resistant polypropylene and nano far-infrared master batches polypropylene (0, 8 and 10 wt%)
The composite plates were processed from one to six times.

Figure. 1 shows the tensile strength of the IRPP/NFMPP composite plates consisting of different NFMPP proportions (0, 8 and 10 wt%). Tensile strength of the 8 wt% NFMPP were slight higher than that of the 0 wt% NFMPP the powders within NFMPP were of 0.5 (μm). To add powder of micronmeter enhanced the physical property of composite (5) (6) , we used NFMPP to reinforce the PP's physical property.

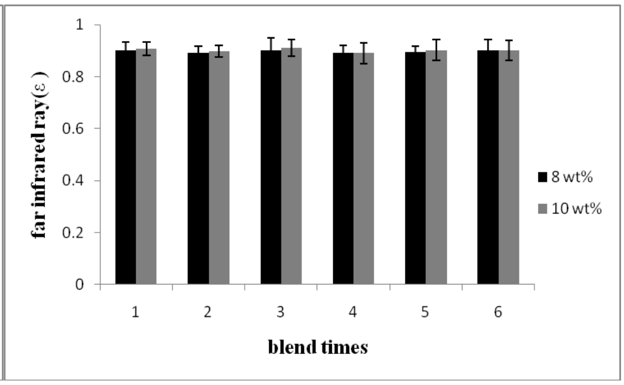
The same process was repeated for one to six times.The tensile strength of the IRPP was lowered gradually as the processing times incresed. In Figure 1, the tensile strength of the IRPP/NFMPP composite plate processed for six times was slightly lower than that which was processed for only one time. The IRPP's molecule chain was disconnected by shear stress when the single-screw extrusion spewed out the heated mixture. This disconnection shortened the chain length; thus, the IRPP/NFMPP's tensile strength was weakened as well.

In Figure 2,impact strength of the 0 wt% NFMPP was 357.62 J/m. Those of the 8 wt% and 10 wt% NFMPP were 347.612 J/m and 347.634 J/m in plates processed once, because PP chain was not broken in the belnd processing from one to three times.

That powder reunited with powder lead to stress concentration in the composite plates. The NFMPP's powder was inconsistent in the 8 wt% and 10 wt% composite plates's Izod impact strength. When the times of process increased to six times, the impact strength dropped to 299.83 J/m.The impact strength decreased as more processings were conducted . The high temperatures and screw sheer also disconnected the molecule chain.



(a)



(b)

(a) Figure. 3 The flexural streagth of impact-resistant polypropylene and the nano far-infrared master batches polypropylene (0, 8 and 10 wt%)
The composite plates are processed for one to six times.

(b) Figure. 4 The far infrared ray emissivity of impact-resistant polypropylene and nano far-infrared master batches polypropylene (0, 8 and 10 wt%)
The composite plates are processed for one to six times.

Fig. 3 shows the unapparent flexural strength results, when the processing times were increased to six times on the 0 wt% NFMPP. However, the 8 wt% and 10 wt% NFMPP's flexural streagth were 36.45 Mpa and 36.54 Mpa, slightly higher than the 0 wt% NFMPP's 34.50 Mpa in the plate processed for four times. NFMPP's powders were dispersed evenly in between the matrix and powders. Consequently, the more the processing, the more evenly the NFMPP was dispersed and the better the tensile flexural strengths.

Figure.4 shows the far infrared ray emissivity were identical (0.9 ε) for the composite plates, including 8, and 10 wt% of NFMPP, which were processed from one to six times. The powders (Al2O3, ZnO2 and ZrO2) within NFMPP emit far-infrared radiation; moreover, there emissive effects were intact regardless of processing times.

4.Summary

In this study, we successfully made far-infrared/impact-resistant Poly(propylene) composite plates in which the 8 and 10 wt% NFMPP were used to strengthen the IRPP matrix . Poly(propylene) composite plate’s Izod impact strengths were decreased by the additional NFMPP. Mechanical properties were reduced when the composite plates were processed from one to six times, because PP molecular chains were broken by the high temperatures.

If the body far infrared ray emissivity achieve 0.85 ε，which meant good. This simple far infrared ray emissivity achieve 0.9 ε， even though the composite plates were processed from one to six times or with the additional NFMPP for 8 and 10 wt%.

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