

Structural Changes in Oligomers and Additives in Polypropylene during Mechanical Recycling

Hiroataka Shioji¹⁾ Nobuko Taniguchi¹⁾ Suguru Tamura¹⁾ Toru Yamanaka¹⁾

Riku Hashimoto²⁾ Ryo Ikegami²⁾

1) Toray Research Center, inc. 3-2-11, Sonoyama, Otsu, Shiga 520-8567, Japan (E-mail: Hiroataka.shioji.s5@trc.toray)

2) AISIN CORPORATION, 2-1 Asahi-machi, Kariya, Aichi 448-8650, Japan

KEY WORDS: KEY WORDS: Environment Energy Resources, Recycling, Polypropylene, GC/MS, Oligomer, Additive (D2)

Polypropylene (PP) is one of the most widely used thermoplastic polymers in automotive, electrical, and medical applications. In the automotive industry, PP accounts for more than half of all plastics used in vehicles; therefore, recycling of PP is an important issue. Recently, the use of recycled materials has been mandated in certain product sectors, creating a need for reliable and objective methods to distinguish recycled materials from virgin materials.

In this study, three potential indicators for identifying recycled PP were investigated: (1) contamination by polyethylene (PE), (2) structural changes in additives, and (3) changes in low-molecular-weight compounds such as oligomers.

Virgin PP compound pellets, recycled PP feedstock pellets, and recycled PP compound pellets supplied by the same compounder (Company X) were analyzed.

To evaluate PE contamination, ¹³C NMR measurements were performed. However, PE was not detected in any of the samples, indicating that the presence of PE is not a reliable indicator of recycled PP.

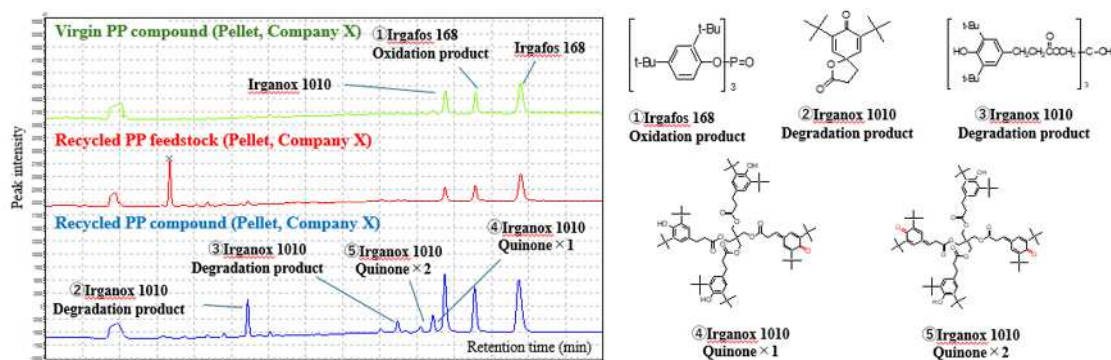


Fig. 1 LC/UV Chromatogram of solvent extract of PP (Company X)

To investigate additive degradation, solvent extracts from the samples were analyzed by LC/UV (Fig. 1). The results showed higher levels of Irganox 1010 degradation and transformation products in recycled PP than in virgin PP. The same tendency was observed for multiple lots obtained from the same compounder. In contrast, analysis of samples obtained from different compounders revealed cases in which virgin PP contained larger amounts of degradation products than recycled PP. These results suggest that additive-derived degradation products strongly depend on additive formulation and processing history, making them unsuitable as universal indicators of recycled PP.

Finally, volatile compounds released during heating were analyzed by GC/MS (Fig. 2). Although no significant differences were observed in the types of compounds detected, differences were found in the peak area ratios of (▼/▽). The peak area ratio decreased in the order of virgin PP compound, recycled PP feedstock, and recycled PP compound, which corresponded to the accumulation of thermal history. Similar trends were also observed in samples supplied by other compounders.

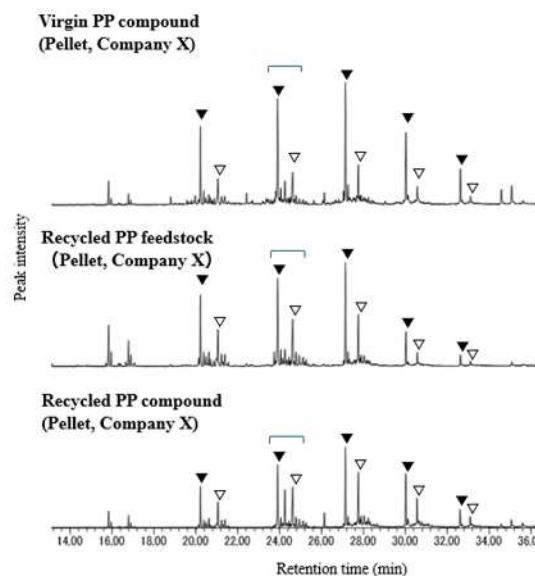


Fig. 2 Gas chromatogram of PP out gas (Pellet, Company X)