

A new simple purity measurement of waste polyethylene-polypropylene mixture by IR analysis with an internal standard compound

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INTRODUCTION

In recent years, the growing demand for recycled plastics such as waste polyethylene (PE) and waste polypropylene (PP) as raw materials for injection molding and extrusion molding products will attract attention as the effective method to put a brake on the depletion of fossil resources in the point of view of the perspective of building a resource-recycling society. The worldwide recovery amounts of PE and PP automatically sorted by optical equipment from the various types of waste plastic collected are about 150 million tons (about 50% of the annual production) and are reused mainly in garbage bags and film products. However, in general, recycled PE products and recycled PP product with a purity of about 80% are only marketed, and there is no recycled product with clear purity. This ambiguous indication of purity was one of the important issues to be solved immediately because it slowed down the effective use of waste plastics. However, since accurate purity analysis is performed only by the expensive measurement NMR method, the development of an inexpensive and simple purity measurement method for waste plastic was an important issue from the viewpoint of effective utilization of waste plastic. Therefore, in this research, we started the development of a simple purity measurement method for waste PE and waste PP using IR analysis method using internal standard compounds. The important points in the development of the simple purity measurement method are (1) the minimization of measurement point error: devising a uniform dissolution method (UD method) for PE and PP and selection of solvent, (2) the internal standard compound with an IR characteristic absorption band to no overlapping of PE and PP, and (3) simple calculation of area ratio by simultaneous calculation of measurement points. The first used 1,1,2,2-tetrachloroethane (TCE), which dissolves PE and PP well, was a carcinogenic solvent, so it was changed to toluene. Using the devised uniform dissolution device (UD device), a calibration curve was prepared from a uniform measurement sheet prepared from PE-PP-toluene-polyvinyl acetate (PVAc, internal standard compound) (IR simple purity measurement method: IRSP method). PerkinElmer's Spectrum was used as the measurement data processing. Furthermore, using this IRSP method, the practicality of measuring the purity of optically sorted waste PE and PP was also verified.

METHODS

Calibration curve

A predetermined amount of toluene (4.5 g), internal standard PVAc (15 mg), PE and PP (0-30 mg) were weighed and heated for 20 minutes to prepare a uniform solution using UD device. The solvent was uniformly evaporated to prepare a solid sample of the mixture. After 20 random IR measurements, a calibration curve

was created from the area ratio (SPE / SPVAc and SPP / SPVAc) and weight ratio (WPE / WPVAc and WPP / WPVAc) of each characteristic absorption band (Fig. 1).

RESULTS AND DISCUSSION

Comparison between IRCP method and NMR purity measurement method using PE and PP rich products (from Ecoport Kyushu Co., Ltd.), which are considered to contain 80% or more of PE-PP obtained from an optical sorter was performed. By heating for 20 minutes, a uniform solution of 30.3 mg of PE-rich product, 14.9 mg of PVAc, and 4.52 g of toluene were prepared. And then, the solvent was uniformly evaporated to prepare a solid sample of the mixture. After 20 random IR measurements, the purity using a calibration curve was 76.1%, and the purity of the PP-rich product was also 86.3%. As a result of measuring each by the NMR method with deuterated 1,1,2,2-tetrachlorethylene, each purity of PE and PP were 82.0%. The measurement difference of PE was -5.9% and the measurement difference of PP was + 4.3%. These results suggested that this IRSP method is effective as an inexpensive and simple purity measurement of PE-PP more than the NMR method.

CONCLUSION

Since the measurement difference range of the IRSP method is smaller than that of the NMR purity measurement method, the development of the low-cost IRSP method will be expected as an important on-site measurement method at the site of the recycling factory in the intermediate treatment industry of PE-PP waste plastic.

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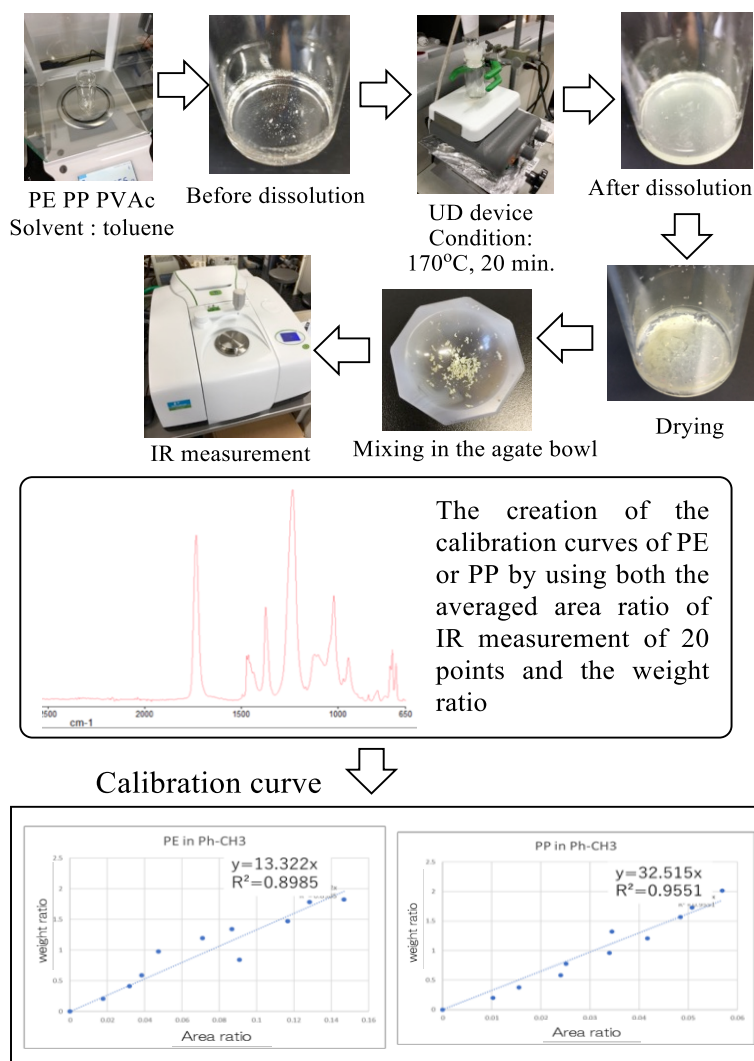


Fig. 1. The creation of calibration curves of PE vs PVAc and PP vs PVAc