Application Note AN-NIR-124

用近外光定聚丙粒中的聚乙含量

Rapid analysis of recycled polyolefins

Next to polyethylene (PE), polypropylene (PP) is the most widely used plastic worldwide. Recycling these polyolefins is problematic, since it is challenging to separate polyethylene from polypropylene using sink float separation. Increasing PE content in PP leads to a poor interfacial bond strength which could negatively impact the mechanical properties of the final molded product.

An efficient method to determine the polyolefin composition based on near-infrared spectroscopy (NIRS) analysis is presented in this Application Note. The main advantage is the short time to result. Compared to the time-consuming standard method (i.e., Differential Scanning Calorimetry or DSC), the analysis of polyethylene content in polypropylene using near-infrared spectroscopy is performed in just seconds.

EXPERIMENTAL EQUIPMENT

Different polymer blends (n = 54) with varying polyethylene content from 0.5–35% were produced in a compounder. The polyethylene content was determined by weighing before the polymer blends were produced. All measurements on the OMNIS NIR Analyzer Solid (Figure 1) were performed in rotation using a large sample cup to average the subsample spectra. This sample setup reduces the influence of the particle size distribution of the polymer particles.

Figure 1. OMNIS NIR Analyzer Solid.

Table 1. Hardware and software equipment overview.

Equipment	Metrohm number
OMNIS NIR Analyzer Solid	2.1071.0010
Large holder OMNIS NIR, 100 mm	6.07402.100
Large cup OMNIS NIR, 100 mm	6.07402.110
OMNIS Stand-Alone license	6.6072.208
Quant Development software license	6.06008.002

RESULT

The obtained NIR spectra (Figure 2) were used to create prediction models for two different polyethylene content ranges. The first correlation diagram (Figure 3) displays the relation between the NIR prediction and the reference values in the range of 0.5–35.0% PE content. Figure 4 displays the correlation in the polyethylene content range of 0.5–9.0%. The respective figures of merit (FOM) show that by selecting a smaller range, the absolute error can be lower compared to using the full PE range.

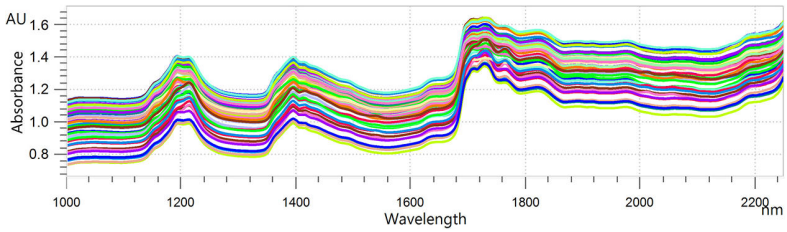

Figure 2. NIR spectra of different polymer blends with varying polyethylene content. Data was obtained with an OMNIS NIR Analyzer Solid.

RESULT PE CONTENT: 0.5–35.0%

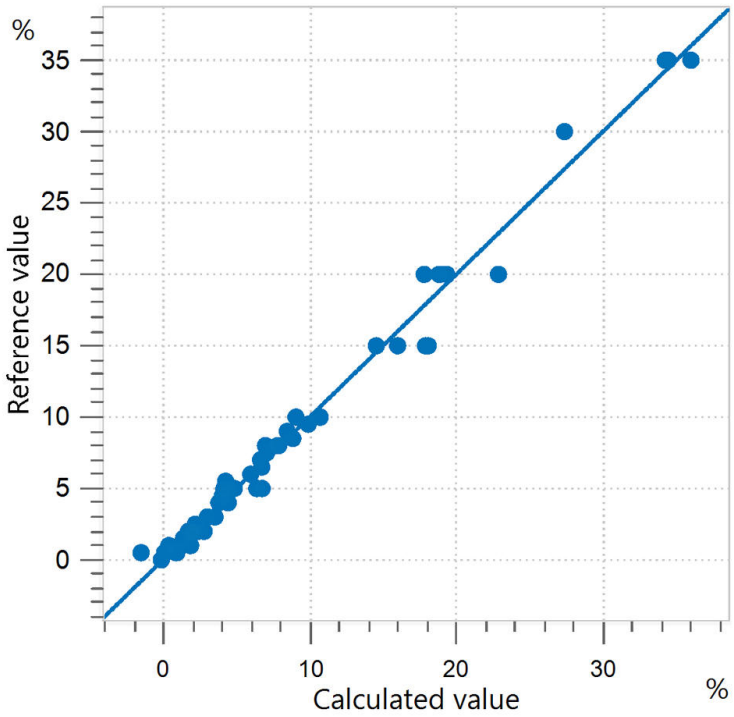

Figure 3. Correlation diagram and the respective FOMs for the prediction of polyethylene content in the range of 0.5–35.0%.

SEC (%)	SECV (%)	R^2CV
0.94	1.10	0.987

RESULT PE CONTENT: 0.5–9.0%

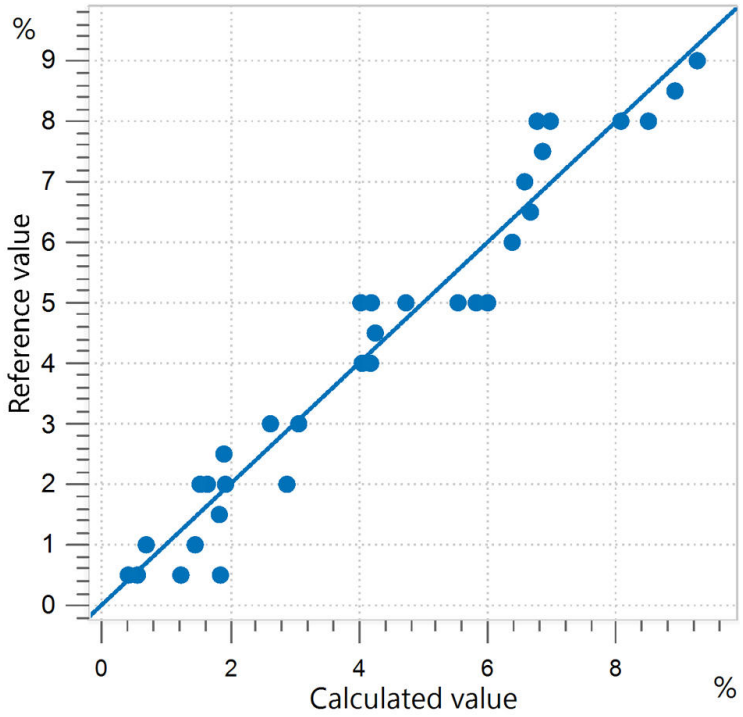

Figure 4. Correlation diagram and the respective FOMs for the prediction of polyethylene content in the range of 0.5–9.0%.

SEC (%)	SECV (%)	R^2CV
0.51	0.60	0.950

CONCLUSION

This Application Note shows the feasibility of NIR spectroscopy for the analysis of polyolefins. Detecting PE concentrations below 5% with the standard Differential Scanning Calorimetry (DSC) method can be challenging and time consuming. Compared to DSC measurements (**Table 2**), near-infrared analysis saves significant time: one sample measurement is performed in a couple of seconds. Next to PE content, physical parameters like density can also be determined with NIRS.

Table 2. Time to result overview for the parameter of polyethylene content.

Parameter	Method	Time to result
PE content	Differential Scanning Calorimetry	60 min per sample

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CONFIGURATION

OMNIS NIR Analyzer Solid
合固体和粘性品的近外光。
OMNIS NIR Analyzer 是一按照瑞士量准和生的近外光 (NIRS) 解决方案,用于整个生的常分析。使用新技和嵌入先 OMNIS Software 反在 NIR 光的速度、可操作性和活使用上。
OMNIS NIR Analyzer Solid 的点概:

- 在 10 秒以内量固体和粘性品
- 自化多位置量,即使在品不均匀,也能得可重的果
- 方便地嵌入自系,或者与其它分析技(滴定)
- 支持大量品容器

OMNIS NIR100 mm
合大品容器的大支架 OMNIS NIR,100 mm (6.07402.110)。
允明地定位品容器和旋品容器。