



Application Note AN-NIR-124

用近红外光谱测定聚丙烯颗粒中的聚乙烯含量

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 ² CV
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 ² CV
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

适合固体和粘性样品的近红外光谱仪。

OMNIS NIR Analyzer 是一种按照瑞士质量标准开发和生产的近红外光谱 (NIRS) 解决方案,用于整个生产链的常规分析。使用新技术和嵌入先进 OMNIS Software 反应在该 NIR 光谱仪的速度、可操作性和灵活使用上。

OMNIS NIR Analyzer Solid 的优点概览:

- 在 10 秒以内测量固体和粘性样品
- 自动化多位置测量,即使在样品不均匀时,也能够获得可重现的结果
- 方便地嵌入自动系统,或者与其它分析技术(滴定)关联
- 支持大量样品容器



OMNIS NIR100 mm

适合大样品容器的大支架 OMNIS NIR,100 mm (6.07402.110)。

允许明确地定位样品容器和旋转样品容器。