

Application News

Fourier Transform Infrared Spectrophotometer IRSpirit™-X

FTIR Analysis of Recycled Plastics Using the Spectrum Advisor Function

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User Benefits

- ◆ FTIR spectrophotometers are useful for qualitative analysis of a wide variety of plastics.
- ◆ With FTIR, it is possible to measure and analyze black or dark-colored plastics that cannot be measured by plastic automatic sorting devices that utilize near-infrared light.
- ◆ The Spectrum Advisor function ensures the acquisition of high-quality data.

■ Introduction

In recent years, there has been increasing interest in plastic recycling internationally. The United States announced its National Recycling Strategy¹⁾ on November 15, 2021, aiming to increase the recycling rate to 50% by 2030. In Europe, an amendment to Directive 94/62/EC on packaging and packaging waste²⁾ was announced on November 30, 2022, which proposes packaging waste reduction targets by 2040, the introduction of a common material labeling system, and a minimum recycled plastic content in plastic packaging. In Japan, the Plastic Resource Circulation Promotion Law came into effect on April 1, 2022.

Various sorting technologies, such as density separation, electrostatic separation, near-infrared/infrared sorting, Raman spectroscopy sorting, and X-ray transmission density sorting are utilized in the process of plastic recycling. In particular, FTIR spectrophotometer used for infrared sorting, allows for accurate qualitative analysis of polymers and can identify polymers regardless of their color or form (powder/solid), making it useful for sorting a variety of plastics. Moreover, FTIR can be used not only for qualitative analysis during collection but also for confirming the ratios of different plastic types during the acceptance of recycled plastics and for detecting contaminants after molding.

■ Spectrum Advisor

IRSpirit-X series Fourier transform infrared spectrophotometers are compact and portable FTIR systems. Equipped with QATR™-S, a built-in single reflection ATR measurement unit, IRSpirit-X allows for easy measurement of variously shaped samples by simply pressing them onto the prism. However, since plastics brought for recycling come in various shapes, insufficient sample pressing may result in poor spectra and make qualitative analysis difficult. Additionally, spectra may also be affected by the atmospheric environment in some cases. The Spectrum Advisor function newly introduced in the IRSpirit-X series compares the measured spectra with case models and provides advice on parameters, accessories, and troubleshooting related to data processing. As a result, high-quality spectra can be acquired.

In addition to describing examples of plastic measurements, this article also provides an overview of the Spectrum Advisor function.



Fig. 1 IRSpirit™-X with QATR™-S Installed

■ Samples and Analysis Conditions

The transparent bead and black fragment used as plastic samples for this measurement are shown in Fig. 2. The analysis conditions are indicated in Table 1. The QATR-S was used as the ATR attachment.

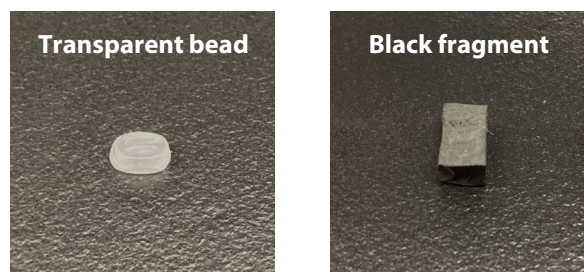


Fig. 2 Appearance of Samples

Table 2 Analysis Conditions

| | |
|----------------------|---|
| Instruments | : IRSpirit-TX and QATR™-S (Diamond, Ge) |
| Resolution | : 4 cm ⁻¹ |
| Accumulation | : 45 times |
| Apodization Function | : SqrTriangle |
| Detector | : DLATGS |

■ Qualitative Analysis of Transparent Bead

The transparent bead was placed on the prism (Fig. 3) and spectra were obtained using the ATR method. The measurement result is shown in Fig. 4. The peaks derived from the bead were very weak, making qualitative analysis difficult. Therefore, the Spectrum Advisor function was used to investigate the cause.

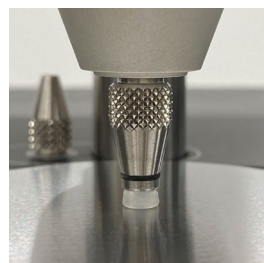


Fig. 3 Transparent Bead Pressed against the ATR Prism

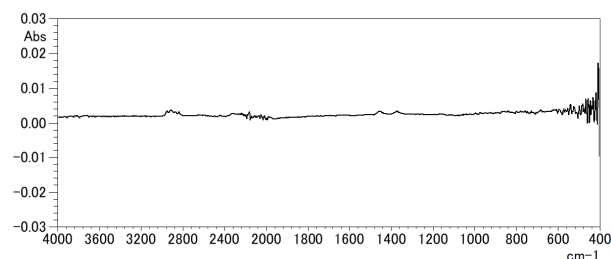


Fig. 4 Spectrum from the Transparent Bead

"Samples-derived peaks not detected" was selected on the following Spectrum Advisor screen, resulting in the suggestion that "the sample and ATR prism may have poor adherence" (Fig. 5). In this case, it was determined that the transparent bead has a dent in the center, that resulted in poor adherence and a poor spectrum.

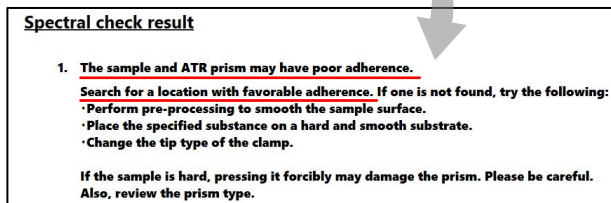
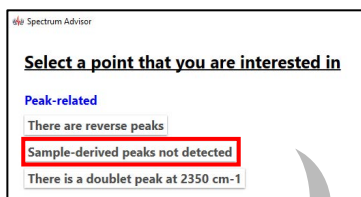


Fig. 5 Investigation by the Spectrum Advisor Function (Transparent Bead)

Therefore, the transparent bead was remeasured with the flat side held in close contact with the prism (Fig. 6). The result is shown in Fig. 7.

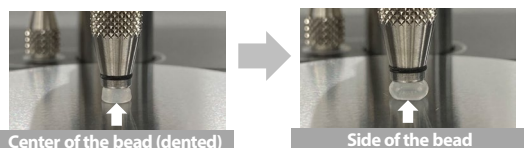


Fig. 6 Change in How the Transparent Bead was Positioned on the Prism

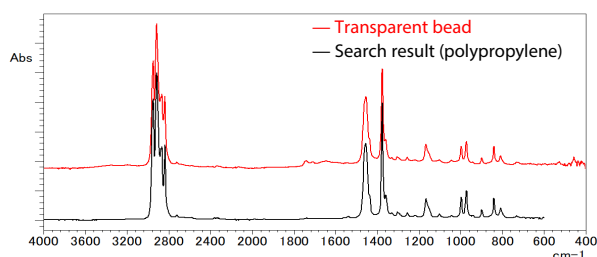


Fig. 7 Spectra from the Transparent Bead and Search Result

By simply changing the sample placement, a good spectrum was obtained and the search result indicated that the transparent bead was probably polypropylene.

■ Qualitative Analysis of the Black Fragment

The measurement result from the black fragment is shown in Fig. 8. Peaks originating from the sample were obtained, but distortion was observed around 800 cm^{-1} , and the baseline was rising toward the right side.

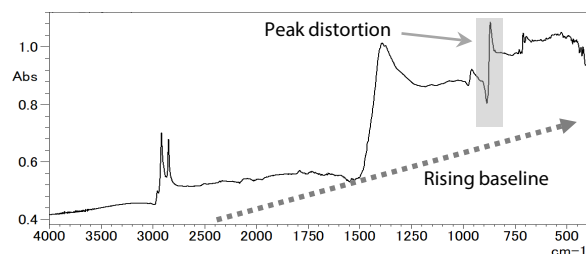


Fig. 8 Spectrum from the Black Fragment

In this case, "Baseline position is a larger value the lower that the wavenumber side becomes (absorbance display)" was selected in Spectrum Advisor, resulting in the suggestion "A large amount of carbon black may be included" (Fig. 9).

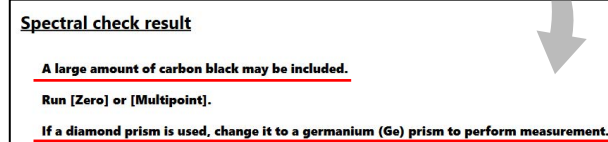
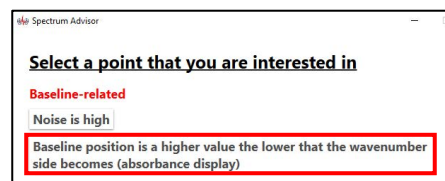


Fig. 9 Investigation by the Spectrum Advisor Function (Black Fragment)

Samples that contain carbon black have a higher refractive index, which can result in peak distortions and rising baselines in spectra. In such cases, a germanium (Ge) prism, with a higher refractive index, is suggested to be used instead of a diamond prism. Fig.10 shows the spectrum obtained with a Ge prism.

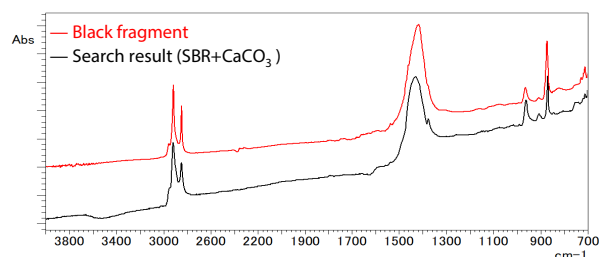


Fig. 10 Spectra from the Black Fragment and Search Result

By changing the prism to Ge, a better spectrum was obtained, with the search result suggesting that the sample was probably a styrene-butadiene rubber (SBR) with an addition of calcium carbonate (CaCO_3).

■ Conclusion

In this study, recycled plastics were analyzed using the ATR method. By utilizing the Spectrum Advisor function, which is included as a standard feature, even individuals with limited measurement experience can perform accurate qualitative analysis regardless of the type or shape of the sample. Furthermore, FTIR allows for the qualitative analysis of various plastics, including black or dark-colored plastics, which would be difficult to analyze using automatic plastic sorting devices based on near-infrared light. This demonstrates its utility for sorting recycled plastics.

References

- 1) National Recycling Strategy (Referenced Oct. 2023)
<https://www.epa.gov/system/files/documents/2021-11/final-national-recycling-strategy.pdf>
- 2) Regulation of the European Parliament and of the Council (Referenced Oct. 2023)
<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022PC0677>

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