Application News

No. A647

IRSpirit™ Fourier Transform Infrared Spectrophotometer

Analysis of Ultraviolet-Degraded Plastic by Plastic Analyzer

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User Benefits

◆ Degradation analysis and contaminants analysis of plastics can be carried out easily, even by users who are not familiar with FTIR measurement.

◆ Smooth analysis of degraded plastics is possible by using Shimadzu proprietary UV-damaged and thermal-damaged plastics libraries.

■ Introduction

Plastic materials are one of the various types of contaminants that occur in production lines. Although qualitative analysis of most plastic contaminants is possible by using a commercial database, correct identification of plastics which have been degraded (damaged) by ultraviolet (UV) radiation or heat is difficult due to changes in the pattern of the infrared spectrum. The libraries included in Shimadzu FTIR-based Plastic Analyzer contain infrared spectra of plastics that have been damaged by UV radiation and heat, and enable highly accurate qualitative analyses which reflect the state of degradation.

This article introduces an example of an analysis of a UV-degraded plastic sample utilizing Plastic Analyzer.

■ Plastic Analyzer

Plastic Analyzer (Fig. 1) is a system which comprises the IRSpirit Fourier transform infrared spectrophotometer, the QATR™-S single-reflection ATR measurement accessory, and the Plastic Analyzer method package, and is an effective product for contaminants analysis and degradation analysis.

The method package includes Shimadzu proprietary UV-damaged plastics and thermal-damaged plastics libraries, together with a macro program which provides the optimum measurement parameters. In addition, the attached analysis handbook contains the compositional formulas, infrared spectra, and characteristic peak vibration modes of 14 types of plastics.

Fourier Transform Infrared Spectrophotometer Plastics Analysis System

Plastic Analyzer

Composition:
● IRSpirit Fourier transform infrared spectrophotometer
● QATR-S single-reflection ATR measurement accessory
● Plastic Analysis method package
   1. UV-damaged plastics library
   2. Thermal-damaged plastics library
   3. Dedicated program/parameters for IR Pilot™

Fig. 1 Plastic Analyzer

■ UV-Damaged Plastics Library

This proprietary Shimadzu library includes the infrared spectra of plastics degraded by UV radiation, and was created by irradiating UV radiation on 14 types of plastics for up to a maximum of 550 hours (equivalent to UV exposure for approximately 10 years) using a super accelerated weathering chamber manufactured by Iwasaki Electric Co., Ltd. In addition to contaminants analysis and degradation analysis, it is also an effective tool for analysis of microplastics, which have attracted considerable attention in recent year.

■ Thermal-Damaged Plastics Library

The thermal-damaged plastics library is also a proprietary Shimadzu library. Created with the cooperation of the Hamamatsu Technical Support Center of the Industrial Research Institute of Shizuoka Prefecture, it includes the infrared spectra of 13 types of plastics measured in the unheated condition and after degradation by heating to 200 ˚C to 400 ˚C.

■ Measurement Samples

A plastic part on a blind was analyzed after long-term exposure to sunlight indoors at a window. Fig. 2 shows a photograph of the measurement sample. The measurements were done using a fragment obtained by cutting out the inside of the sample (inside), a part of the sample on the indoor side that was not exposed to direct sunlight (indoor side), and a part that was estimated to have been yellowed by exposure on the window side (window side).
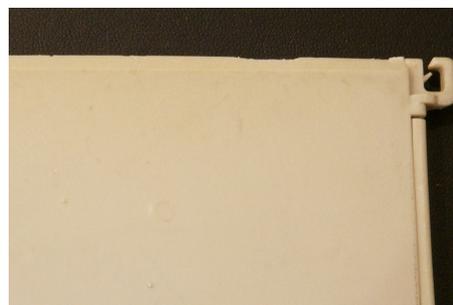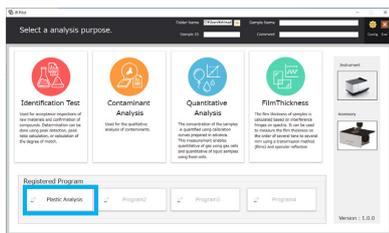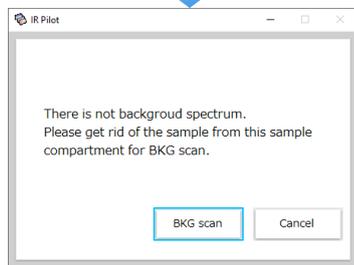

Fig. 2 Measurement Sample

The operations in this analysis were carried out using the dedicated IR Pilot macro program included in the Plastic Analyzer method package. With this program, the optimum analysis parameters for the plastic analysis are set in advance, and all operations from the actual measurement to printing the report can be carried out simply by clicking the screen. Fig. 3 shows the operation workflow.
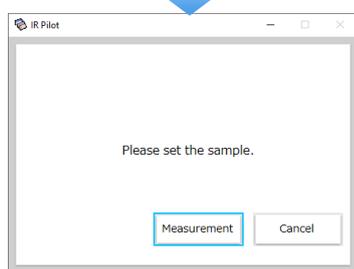
Select the Plastic Analysis measurement program

Background measurement

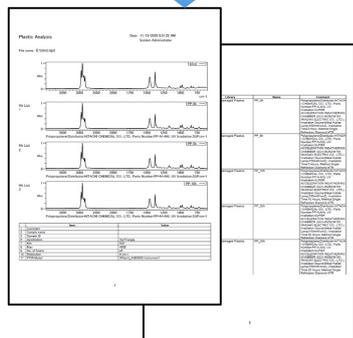Sample measurement

Spectrum search and report printout

Fig. 3 Operation Workflow

– inside
– Indoor side
– Window side (yellowed part)

Fig. 4 Measurement Results of Sample by Plastic Analyzer

– Indoor side
– PP irradiated with UV for 40 h (UV-damaged plastics library)
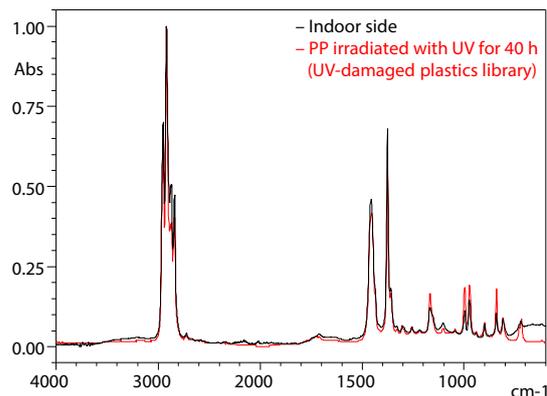
Fig. 5 Search Result (Indoor Side)

– Window side (yellowed part)
– PP irradiated with UV for 125 h (UV-damaged plastics library)

Fig. 6 Search Result (Window Side)

■ Measurement Results

Fig. 4 shows an overlay of the IR spectra measurement results obtained by Plastic Analyzer. According to the UV-damaged plastics library, the inside of the plastic part on a blind is considered to be polypropylene (PP) which has not been exposed to UV radiation. The indoor side of the sample showed a spectrum similar to that of PP irradiated with UV for 40 hours (Fig. 5), and the window side (yellowed part) showed a spectrum similar to that of PP irradiated with UV for 125 hours (Fig. 6).

As a result of degradation by sunlight, that is, UV radiation, peaks were formed in the vicinities of 3400 cm^{-1}, 1710 cm^{-1}, and 1150 cm^{-1}, and these are thought to be the result of absorption associated with the O-H stretching, C=O stretching, and C-O stretching vibration due to the progress of oxidation. The surface of PP undergoes oxidative degradation as a result of exposure to UV radiation, and it was possible to estimate the degree of degradation.

■ Conclusion

Quick qualitative analysis of a UV-degraded plastic sample was possible by using the FTIR-based Plastic Analyzer. The entire analysis process from setting the measurement parameters to the measurement and the library search and preparation of the report can be automated by using Shimadzu proprietary method package, enabling easy analysis of plastics. Highly accurate spectrum search and qualitative analysis reflecting the state of degradation are possible by using the UV-damaged and thermal-damaged plastics libraries included in the method package.

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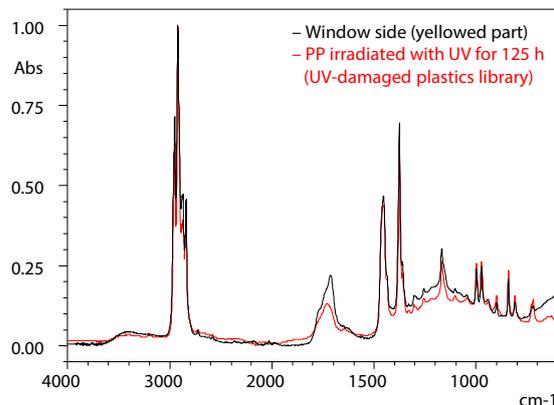Analytical & Measuring Instruments Division
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