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Application News

Spectrophotometric Analysis

Application of Shimadzu Thermal-Damaged Plastics Library

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■ Introduction

Plastics are an inevitable part of our lives. They are extensively used in household items, electrical equipment, automobile parts and packaging, just to name a few. In many instances, plastics are constantly subjected to heat that leads to their physical deformation and chemical change. Understanding the chemical change in plastics with heating is especially important because it can provide vital information, such as the temperature of the heat source and time exposed to it.

Fourier Transform Infrared (FTIR) spectroscopy is a powerful tool that is used to analyze and identify plastics. Commercial FTIR libraries are available that help identify plastics; however, currently these libraries only contain spectra of plastics in their standard (room temperature) state. Since plastics go through significant chemical change when exposed to heat, these libraries often offer little to no help when it comes to the analysis of thermally degraded plastics. With this in mind, Shimadzu has released a Thermal-Damaged Plastics Library that contains FTIR spectra of multiple types of plastic that have been subjected to various degrees of thermal degradation.

■ Sample Analysis

In order to demonstrate the use of the Shimadzu Thermal-Damaged Plastics Library, controlled heating of three different types of plastics was carried out – Acrylonitrile butadiene styrene (ABS), Nylon 6-6 and Polyethylene (PE). Samples of each plastic type were separately heated at 200°C and 300°C for two hours in a temperature-controlled muffle. To prevent any cross-contamination caused by fumes of burned samples, only one sample was heated at a given time. To further reduce the chance of cross contamination, the muffle furnace was purged of any remaining residual plastic by heating to 1100°C for two hours with ventilation between each sample type.

After the thermally treated samples were cooled to room temperature, FTIR spectra were obtained using a Shimadzu IRTracer-100 FTIR Spectrophotometer equipped with an ATR accessory. In addition, FTIR spectra of unheated samples (untreated plastics) were also collected for comparison. As a representative example, PE samples subjected to 200°C and 300°C for two hours are shown beside an untreated PE coupon in Figure 1. The samples show typical physical change cause by exposure to heat.

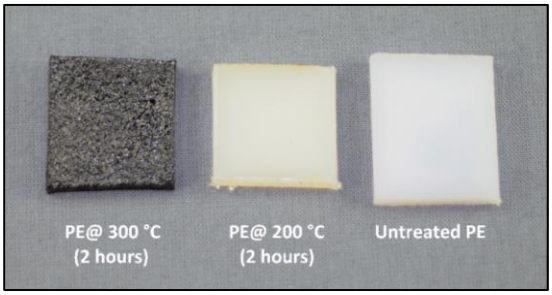

Figure 1: Physical appearance of (from left to right) polyethylene subjected to 300 °C for 2 hours, polyethylene subjected to 200°C for 2 hours and untreated polyethylene.

FTIR spectra of all samples were compared against the Thermal-Damaged Plastics Library using Shimadzu LabSolutions IR software. Figure 2(a), 2(b) and 2(c) show comparisons of three example sample spectra with the matched library spectra – top spectrum in each figure is the user-obtained spectrum and the bottom spectrum is the standard spectrum from the Thermal-Damaged Plastics Library. In addition to those shown in the figure, all user-obtained plastics sample spectra demonstrated a very good match with the library spectra.

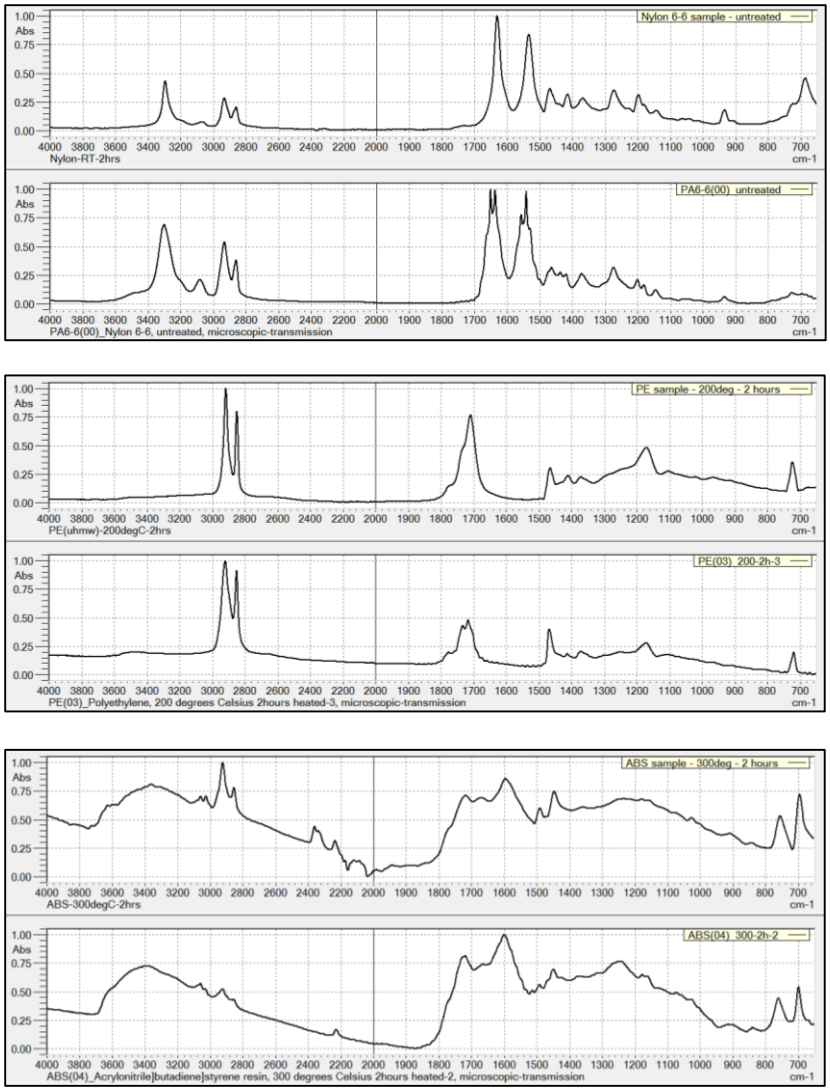

Figure 2: Comparison of user-obtained spectra with the Thermal-Damaged Plastics Library spectra of (a) untreated Nylon 6-6 sample, (b) PE sample heated at 200°C for 2 hours and (c) ABS sample heated at 300°C for 2 hours. Each figure contains a user-obtained spectrum (top) and the library matched spectrum (bottom)

■ Conclusion

The Shimadzu Thermal-Damaged Plastics FTIR Library offers a means for effective and rapid identification of several types of plastics (including thermoplastics and thermosets) that have gone through chemical changes due to thermal degradation. This Shimadzu Library along with Shimadzu's LabSolutions IR software serves as a great combination to aid in forensic analysis, electronic fault analysis, scientific research, manufacturing, and contaminant analysis.

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