Evolved Gas Analysis of a Polyurethane Foam

Application Note
EGA - Plastics

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Many polymers, including PVC and polyurethanes, degrade in a step-wise fashion when pyrolyzed. This may easily be demonstrated and studied by interfacing the Pyroprobe directly to a mass spectrometer. By replacing the GC column with a one-meter length of 0.1 mm fused silica, the pyrolysis products are transferred rapidly to the detector as they are made. The interfacing, inlet pressure and split ratio are used just as they would be for GC-MS analysis, but rather than producing a chromatogram of individual compounds, the results are composite peaks of the materials made during the heating process.

Figure 1 shows a piece of polymer foam heated from 200° to 800°C at 100°C/minute. Two large peaks result, with maxima at 2.2 and 3.2 minutes. These correspond to the major products formed from polyurethanes when heated. First, at a relatively low emperature, the diisocyanate is released. In the second stage, the remaining polyol fraction is pyrolyzed. Examining the mass spectra of these composite peaks reveals a large mass for ion 174 in the first peak, which is characteristic for toluene diisocyanate. Just as with normal chromatography, individual ions may be plotted out to show the evolution of specific compounds. In Figure 2, ion 174 for toluene diisocyanate is shown, creating the first peak. The second peak is represented by ion 43 for polyol fragments.

This technique may also be used to study the evolution of volatiles such as residual monomers and additives, creating a simulated TGA with mass spec information about the compounds evolved during a specific heating regime.

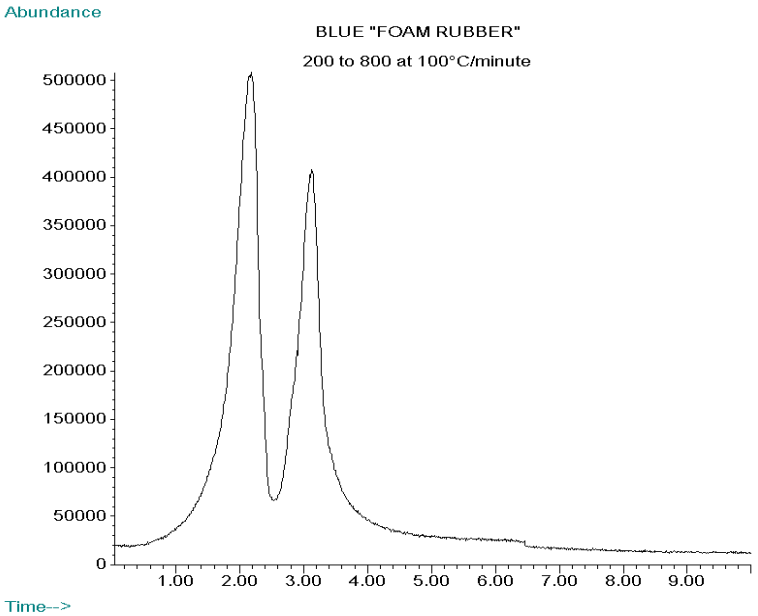

Figure 1. Polyurethane foam heated at 100°C/minute direct to mass spectrometer.

Instrument Conditions
Pyroprobe

Pyrolysis:	
Initial:	200°C
Ramp:	100°C/ minute
Final:	800°C
Valve Oven:	300°C
Transfer Line:	300°C

GC/MS

Column:	1m x 0.1mm fused silica
Carrier:	Helium, 50:1 split
Injector:	300°C
Oven:	250°C, isothermal 10 minutes
Mass Range:	35-550

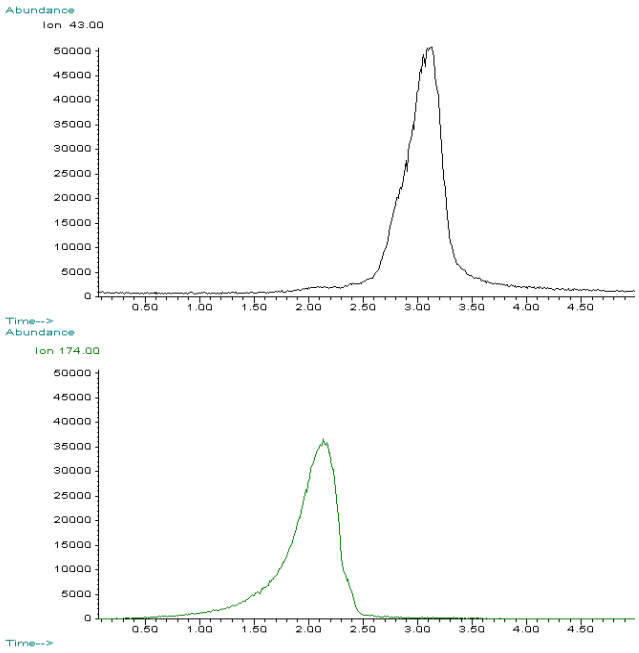

Figure 2. Ion 43 for polyol (top) and ion 174 for diisocyanate (bottom).

FOR MORE INFORMATION
CONCERNING THIS APPLICATION, WE RECOMMEND THE
FOLLOWING READING:

T. Wampler, C. Zawodny, K. Jansson, Multistep thermal characterization of polymers using GC-MS, American Lab, 39, 6, (2007) 16-19.