

## Pyrolysis-GC/MS of Polyurethanes

Polyurethanes are a versatile group of polymers found in a wide array of manufactured products ranging from packaging foams, through elastics, paints and molded goods. All polyurethanes are produced from a polyol and a diisocyanate, and when pyrolyzed, polyurethanes regenerate the diisocyanate, which may be used as a marker for this family of polymers. This is true whether the material is a pure polyurethane or a blend or composite with only a small amount of polyurethane in the composition.

Figure 1 shows the pyrogram of a typical clear-gloss exterior polyurethane finish for wood. About 100 µg of the dried finish was heated to 750°C for 15 seconds to produce the pyrolysis compounds. The diisocyanate in this product is toluene diisocyanate (TDI) which elutes at about 14 minutes and is the largest peak in the chromatogram. The later eluting peaks are long-chain unsaturated fatty acids, including oleic acid.

A polyurethane material used for shoe soles was pyrolyzed to produce the pyrogram in Figure 2. In this case, the diisocyanate was 1,1'-methylenebis(4-isocyanato-benzene) (MDI), which is also regenerated from the polymer and in this case is again a major peak in the chromatogram, eluting at about 22 minutes. The peak at 4 minutes is cyclopentanone, which is produced from adipic acid containing polymers, and indicates that the polyurethane used a polyester-type polyol in its formulation.

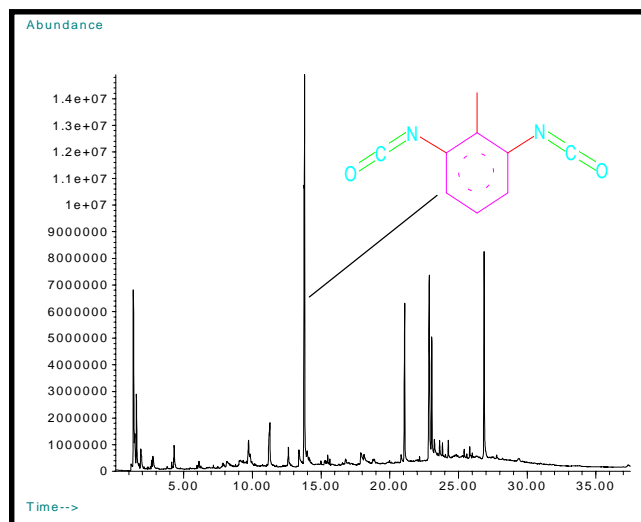


Figure 1. Clear polyurethane finish.

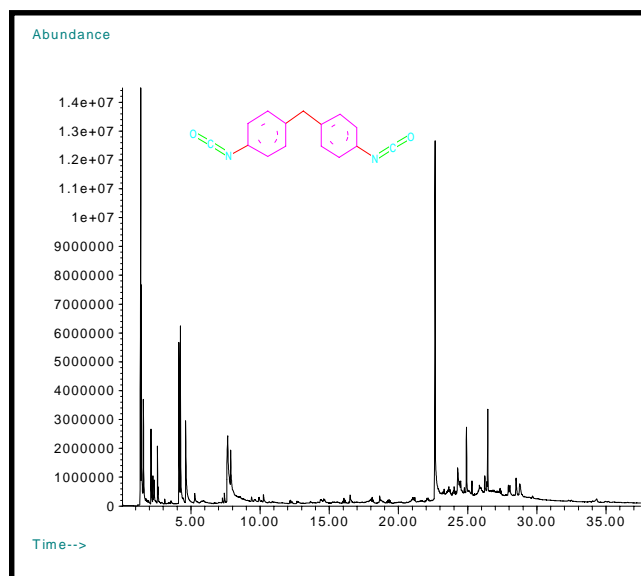


Figure 2. Polyurethane shoe sole.

## Equipment

Samples were pyrolyzed in a quartz tube, using the CDS Analytical Model 2500 pyrolysis autosampler interfaced to an Agilent 6890 gas chromatograph with a model 5972 mass selective detector.

### Model 2500 Conditions

Valve Oven: 300°C  
Temperature: 750°  
Time: 15 seconds  
Clean temp.: 1000°C  
Time: 10 seconds  
Purge flow: 20 ml/min.

### GC Conditions

Carrier: Helium  
Split: 75:1  
Column: HP-5 (30 m X 0.25 mm)  
Detector: MSD  
Scan range: 35 - 500 amu

### GC Program:

Initial: 40°C for 2 minutes  
Ramp: 10°C/min.  
Final: 300°C for 5 minutes

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

H. Ohtani et al., Characterization of Polyurethanes by High-Resolution Pyrolysis-Capillary Gas Chromatography, JAAP, 12 (1987) 115-133.

Additional literature on this and related applications may be obtained by contacting your local CDS Analytical representative, or directly from CDS at the address below.



CDS Analytical, Inc. has been a leader in the design and manufacture of laboratory instruments for sample preparation and analysis since 1969. We are dedicated to providing the best possible instruments for both research and routine analysis. Well known in the field of pyrolysis, CDS manufactures the Pyroprobe® 1000, 2000 and 2500 autosampler for the introduction and analysis of solid materials by GC, MS and FT-IR. CDS offers a complete line of dynamic headspace instruments for the analysis of volatile organic compounds in environmental, pharmaceutical and food applications, including the model 6500 16 position autosampler for complex, multicomponent materials investigation. Our customers, their requirements and applications are important to us. To help meet your needs, we offer a wide range of analytical information and the services of our applications laboratory. If you would like additional information, please contact us at the address below, call us at 1 800 541 6593, or log onto [www.cdsanalytical.com](http://www.cdsanalytical.com).