

Pyrolysis-GC of High and Low Density Polyethylene

Polyethylene, whether high density (HDPE) or low density (LDPE) is essentially a very long hydrocarbon molecule. Pyrolysis of PE produces shorter hydrocarbons, mostly normal alkanes, alkenes and dienes, which may be analyzed by gas chromatography, producing a pyrogram like that shown in Figure 1. The recurring pattern of triplet peaks show these paraffins and olefins for a wide distribution of chain lengths, and each triplet contains one more carbon than the triplet which eluted just before it. For example, the large peak at 10 minutes is normal 1-decene, marked C₁₀ in Figure 1.

A major difference between HDPE and LDPE is the increased amount of branching found in LDPE. When a polyethylene molecule is not purely linear, the hydrocarbons produced during pyrolysis retain this structure, and the resulting pyrolysate includes branched hydrocarbons in addition to the normal olefins and paraffins. These branched compounds elute between the triplets of the normal compounds, as shown in Figure 2. Here the region between decene and tetradecene has been expanded to show the branched materials eluting between the normal hydrocarbons, and it is clear that the degree of branching, and thus the kinds and amounts of non-linear hydrocarbons is substantially greater for the LDPE.

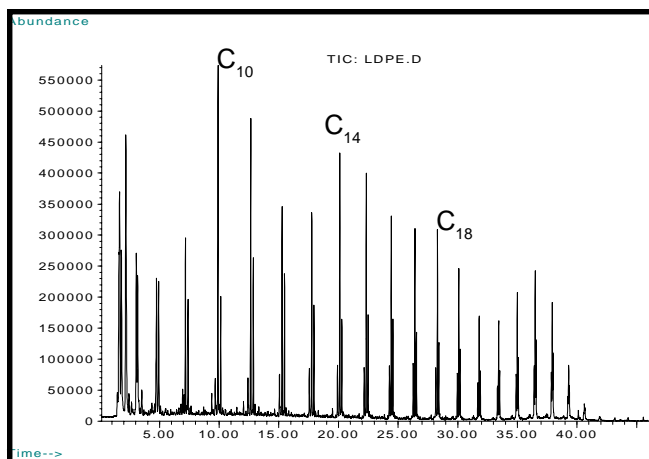


Figure 1. Pyrolysis of low density polyethylene at 750°C.

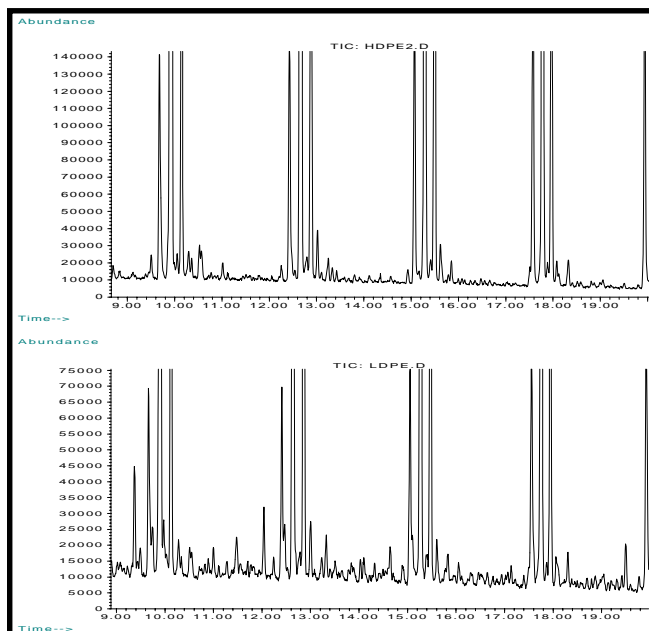


Figure 2. Partial pyrograms of high density (top) and low density (bottom) polyethylene

Equipment

All samples were pyrolyzed using a CDS Model 2500 Pyrolysis Autosampler interfaced to a Hewlett-Packard 6890 gas chromatograph with a mass selective detector.

Pyrolysis

Interface oven: 300°C
Ramp: 10°C/ms
Temperature: 750°C
Time: 15 seconds
Clean: 1000°C for 10 seconds

Chromatography

Carrier: He
Column: HP-5
30 m x 0.25 mm
Split: 75:1
Initial temperature: 40°C for 2 minutes
Ramp: 8°C/minute
Final temperature: 290°C for 10 minutes

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

S. Tsuge, and H. Ohtani, *Microstructures of Polyolefins*, in *Applied Pyrolysis Handbook*, T. Wampler, (Ed)., Marcel Dekker, N.Y., Publisher

S. Tsuge, Y. Sugimura and T. Nagaya, *Structural Characterization of Polyolefins by Pyrolysis-Hydrogenation Glass Capillary Gas Chromatography*, JAAP, 1 (1980) 221.

T. Wampler, *Thermometric Behavior of Polyolefins*, JAAP, 15 (1989) 187.

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.



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