A Comparison of Nylons by Pyrolysis GC

Application Note
Polyamides

Author:

T. Wampler

Aliphatic polyamides have had extensive use in industry in the form of fibers and plastics. Synthetic polyamides known as Nylons are used throughout the world. Since Nylons do not show appreciable volatility at normal GC temperatures, a more intense thermal treatment is necessary for their analysis by GC. Pyrolysis gas chromatography is a method which volatilizes these hard polyamides. The sample is rapidly heated in order to cleave the polymer linkages and produce smaller, more volatile molecules which are readily analyzed by gas chromatography.

Nylons are classified into two categories according to the manner in which they are composed. Nylon 6 and Nylon 12 (Figures 1 and 2) are Ω-amino-carboxylic acid type Nylons, whereas, Nylon 6/12 and Nylon 6/T (Figures 3 and 4) are diamine-dicarboxylic acid type Nylons. When pyrolyzed, polyamides fragment to form mononitriles, amides, mononitriles containing one amide group, and hydrocarbons. The primary product in the pyrolysis of Nylon 6 is 1-caprolactam, formed by the cleavage of the C-N bond in the polymer backbone. Nylon 12 pyrolyzes to give mostly mononitrile pyrolysates.

The chromatogram of Nylon 6/12 (Figure 3) shows an abundance of a dinitrile at a relatively late retention time. The remainder of the chromatogram shows many doublets corresponding to the presence of mononitriles. Nylon 6/T is distinguished from Nylon 6/12 in that Nylon 6/T forms aromatic nitriles when pyrolyzed which are generated from the terephthalamide por tion of the polymer chain.

The reaction of Nylon to the thermal treatment of pyrolysis makes the qualitative identification of Nylon samples quick and easy by generating a reproducible fingerprint for each particular Nylon. Pyrolysis can also be used quantitatively in the analysis of Nylons in a number of different matrices. A wealth of information can be gathered about Nylon samples using pyrolysis gas chromatography.

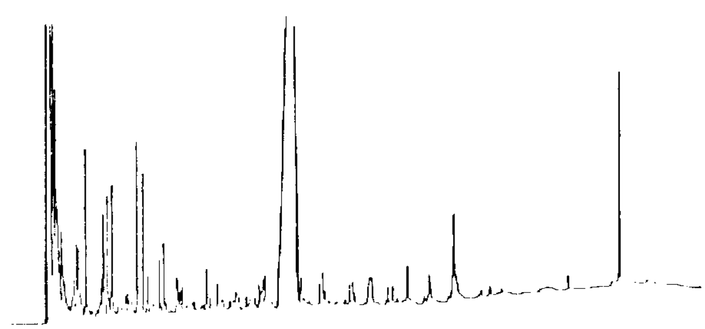

Figure 1. Nylon 6

Instrument Conditions
Pyroprobe

Pyrolysis: 850°C
Interface: 285°C

GC-FID

Column: 50 x 0.25mm SE-54
Injector: 300°C
Oven: 50°C for 3 minutes
then 8°C/min to 285°C

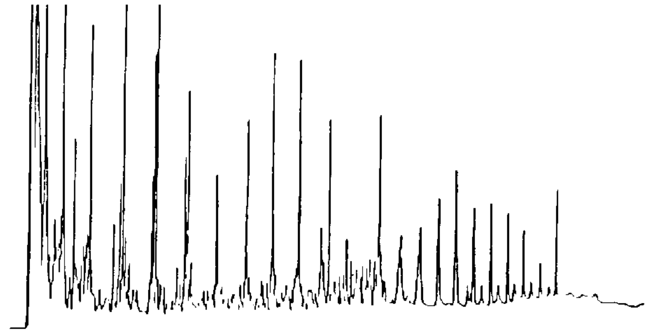

Figure 2. Nylon 12

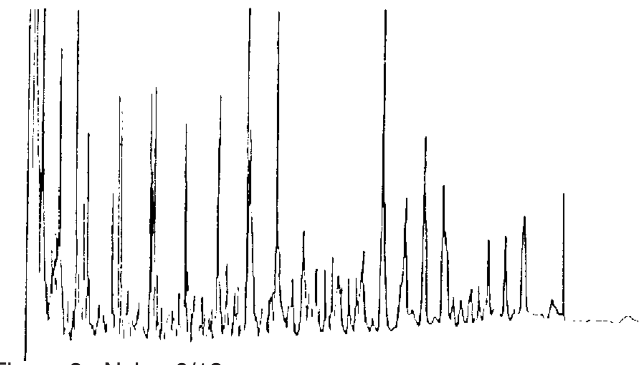

Figure 3. Nylon 6/12

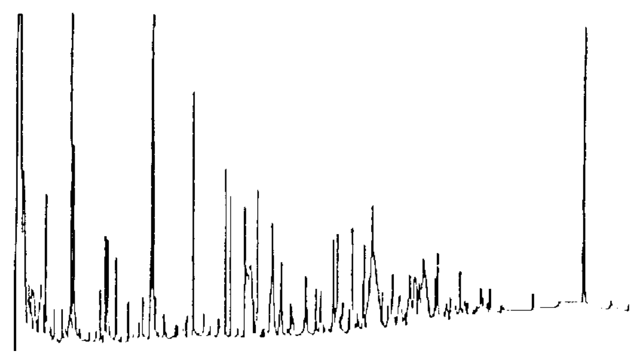

Figure 4. Nylon 6T

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

Huffman, F. and L. Peebles. Journal of Polymer Science, A- 1, 9:1807, (1971).

Nagaya, T. et al. Studies on thermal degradation of aliphatic polyamides by pyrolysis glass capillary gas chromatography. Journal of Analytical Applied Pyrolysis, 4, 117-131, (1982).

Smith, S. Journal of Polymer Science, 30:459, (1958).

CDS Analytical, 465 Limestone Road, P.O. Box 277, Oxford, PA USA 19363-0277 PH: 610 932 3636 FX: 610 932 4158