Application Note TA6001

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TA6001 - Characterizing thermal analysis for polymer product

Introduction

The detection or analysis of the gases evolved during a chemical reaction, as a function of temperature, constitute the techniques of thermal analysis called evolved gas detection (EGD) and evolved gas analysis (EGA), respectively.

Thermal analysis using mass spectrometry covers a large number of related and analytical powerful techniques such as evolved gas analysis using mass spectrometry (EGA-MS) including thermogravimetry-mass spectrometry (TG-MS), temperature programmed pyrolysis-mass spectrometry and temperature programmed desorption mass spectrometry.

In conventional EGA-MS, the evolved gaseous products, which are introduced rapidly to MS, are generally ionized by electron ionization (EI) at 70 eV. In this case, a part of the evolved gaseous molecular ion undergoes further decomposition, and observed simultaneously ions. Especially in the thermal processes, since the evolved gases consists of multiple gaseous species in almost all cases, the resulting fragment ions are overlapped, while the fragment ions provide significant information concerning the structure of the molecule, the apparent mass spectra can be quite complicated. In order to differentiate in real-time the multiple organic species that are evolved in the thermal process, one feasible approach is the use of MS with a selective and soft (fragment-free) ionization technique which avoids fragmentation during ionization.

In the present work we studied nylon. Nylon is a thermoplastic silky material, and is made of repeating units linked by peptide bonds, major representatives are Nylon-6, 6, Nylon-6 and so on. Nylon is valued for its light weight, incredible tensile strength, durability, and resistance to damage. We study several nylons such as Nylon-6, Nylon-6,6, and Nylon-6-MXD, then evaluate the unknown fabricated nylon parts to characterize what kinds of polymer is used for. In this measurement, we employ the electron ionization-MS (EIMS) and photoionization-MS (PIMS) in terms of is ability to produce fragment-free species during the ionization process.

Instrument: Themomass Photo

ThermoMass Photo is an evolved gas analytical system designed for real-time simultaneous measurements of thermogravimetry – differential thermal analysis (TG-DTA) coupled with electron impact ionization (EI) and the fragment-free photoionization (PI) mass spectrometry (MS) that performs measurements as a function of temperature or time.

Measurement and analysis

Using photo ionization mass spectrometry, it is possible to identify the similar architecture of polymers (see Figure 1 (b)).

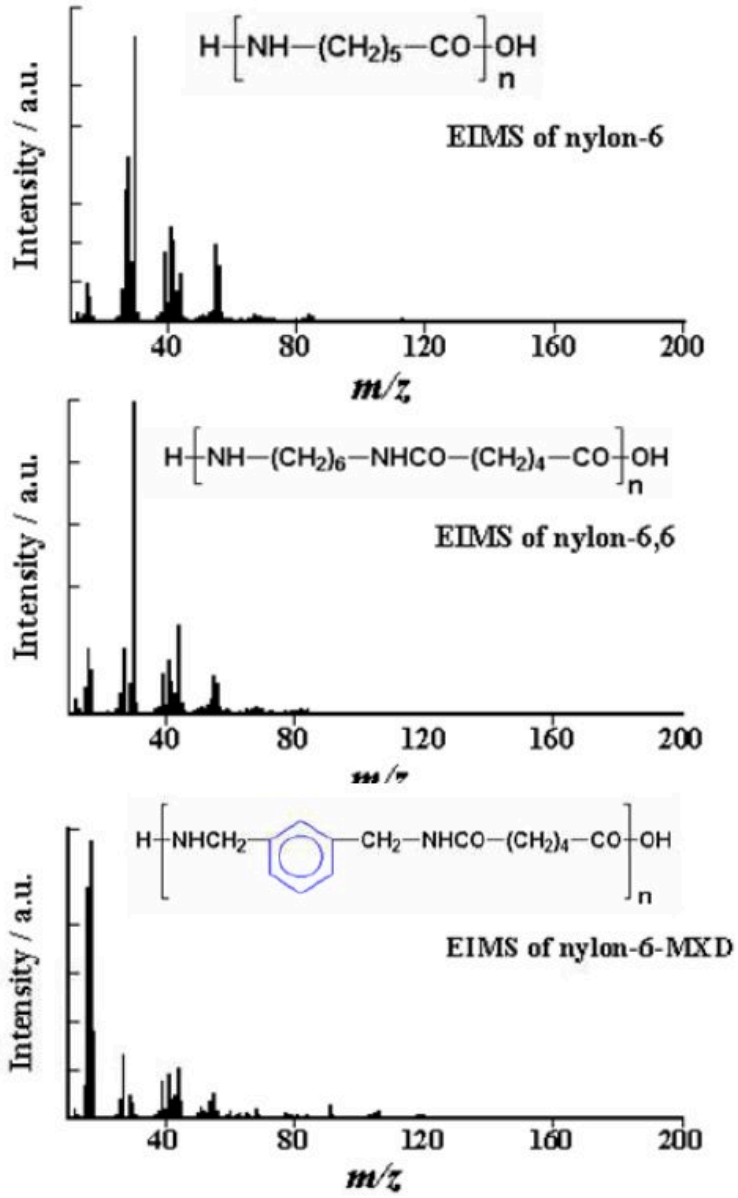

Figure 1(a): EI mass spectra of Nylon-6, Nylon-6,6 and Nylon-6MXD.

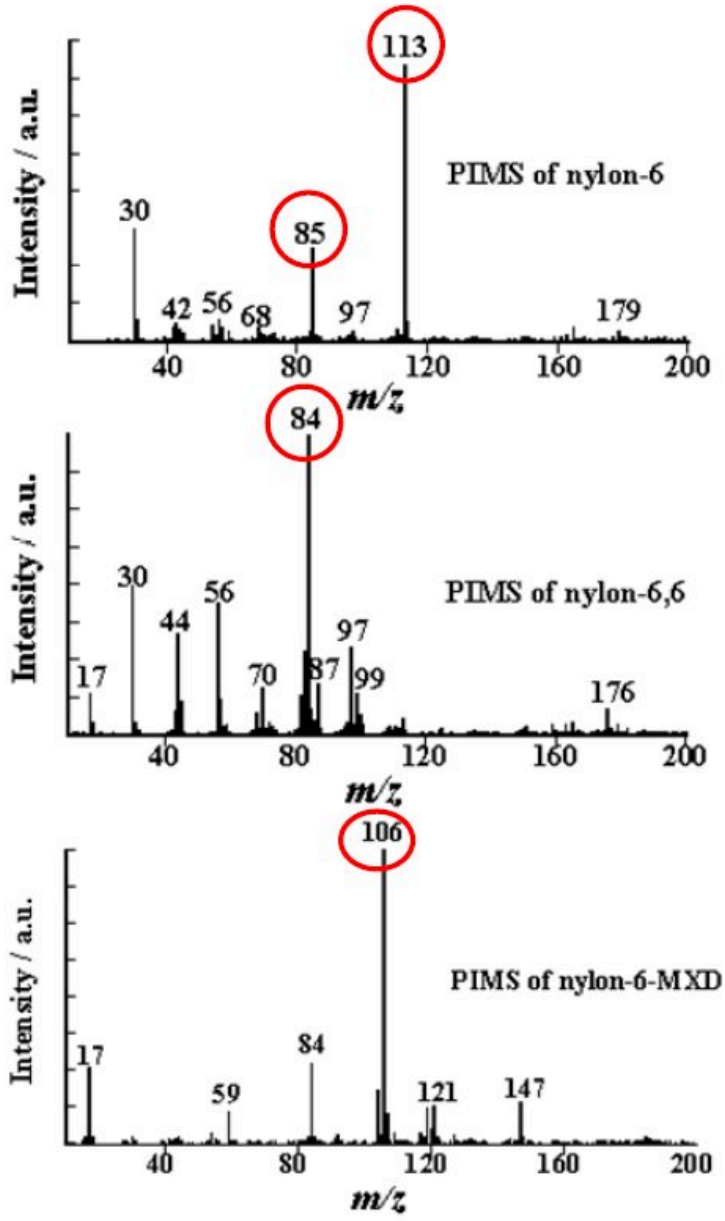

Figure 1(b): PI mass spectra of Nylon-6, Nylon-6,6 and Nylon-6MXD.

It becomes operative for commercially supplied unknown plastic in the rapid identification because of detecting as the difference spectra clearly due to the difference of pyrolytic component oriented backbone architecture of polymer (see Figure 2).

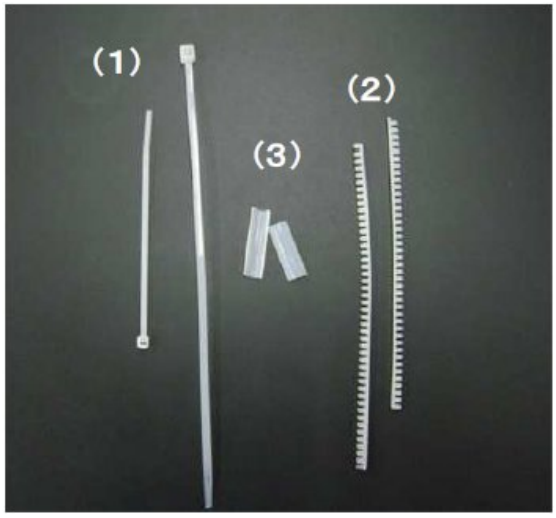

Figure 2(a): Fabricated nylon parts (1) Cable tie (INSULOK tie); (2) Tube; (3) Edge guard

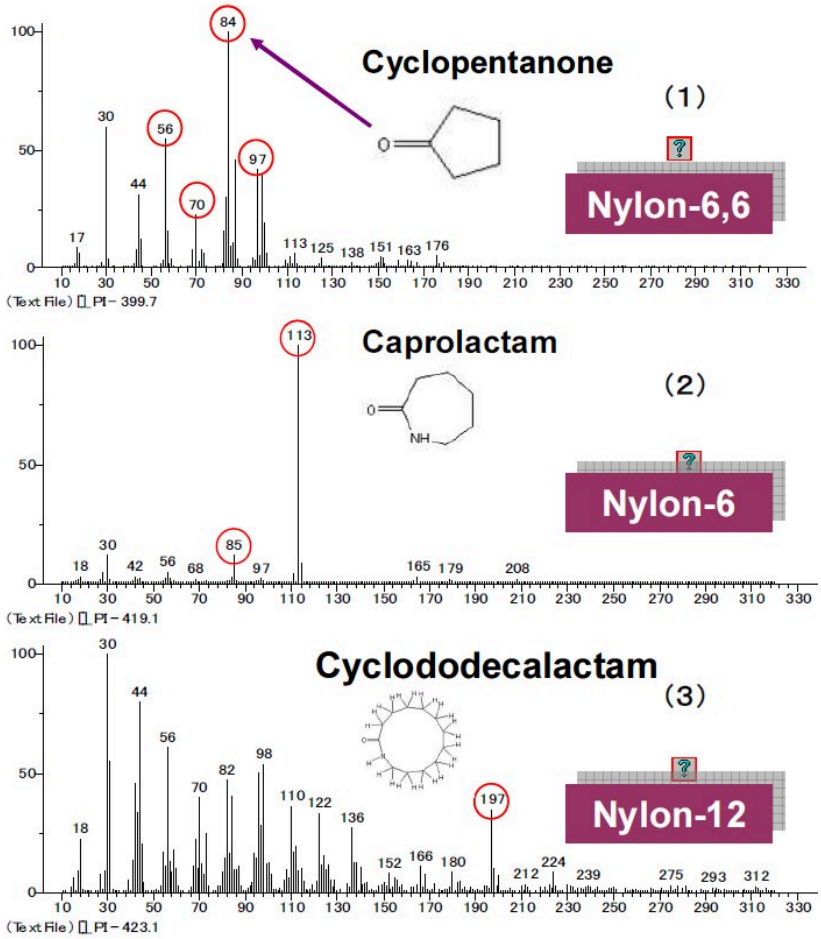

Figure 2(b): PI mass spectra of fabricated Nylon parts.

Related products

ThermoMass Photo

An integrated thermal analysis instrument capable of high-p
recision mass analysis of evolved gases without breaking t
he molecules, allowing direct measurement.