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Study of the Thermogravimetric Analyses Carried out on Polymers with Potential in the Development of Carbon Materials

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Abstract

In this paper, we study the thermal behaviour of polymers – polyethylene (PE), polypropylene (PP), polybutene-1 (PB-1), polyethylene terephthalate (PET) and polybutylene terephthalate (PBT) – in order to identify those able to be transformed into microcellular carbonaceous material. Thermogravimetric analysis (TGA) performed on these polymers (PE, PP, PB-1, PET and PBT) followed the quantity of carbon residue.

Key words: *thermogravimetric analysis, polymers, microcellular carbon.*

Introduction

The microcellular carbon is representative of a new class of carbon materials, a microcellular structure and containing pre-shaped cells distributed uniformly throughout the structure of carbonaceous material obtained by heat treatment of organic polymers. The carbon material was made for a variety of uses which include supports for catalysts, molecular sieves, adsorbents, gas storage, porous electrodes and other parts of batteries, insulators, etc.

The microcellular carbon may be obtained from the pyrolysis of the original matrix polymer, mixed with aggregates having a size of micron and thermally decomposed at high temperatures [1].

Since the polymer matrix is the main component of porous carbon materials, our interest was directed primarily towards identifying some potential polymers possible precursors for such materials.

Experimental study of the thermal behavior of these polymers (PE, PP, PB-1, PET and PBT) by TGA ascertained, according to the amount of carbon residue obtained by proper heat treatment, if these polymers can be used to achieve the necessary matrix to obtain the microcellular carbon.

Experimental Detail

Thermogravimetric analysis (TGA) is an analytical method used to study the thermal stability of the materials (temperature resistance of the polymers and polymeric materials over time and in different environments), and to determine the fraction of volatile components by monitoring the weight change in heating. This method is based on the analysis of mass loss dependence on the

temperature of a sample of material when it is heated to a given speed, constant, until the degradation process had been finished (residual mass remains constant with increasing temperature) - about 900º C [2, 3].

In this work it was used to perform thermal analysis the equipment Mettler Toledo model TGA/SDTA Star System, provided with a program for analyzing thermal effects [4]. The measurements were carried out in air at an oven heating rate of 10ºC/min.

Results

After analyzing the TGA curve recorded for PE, there is a total mass loss in the range of 290-560^{0}C (fig. 1).

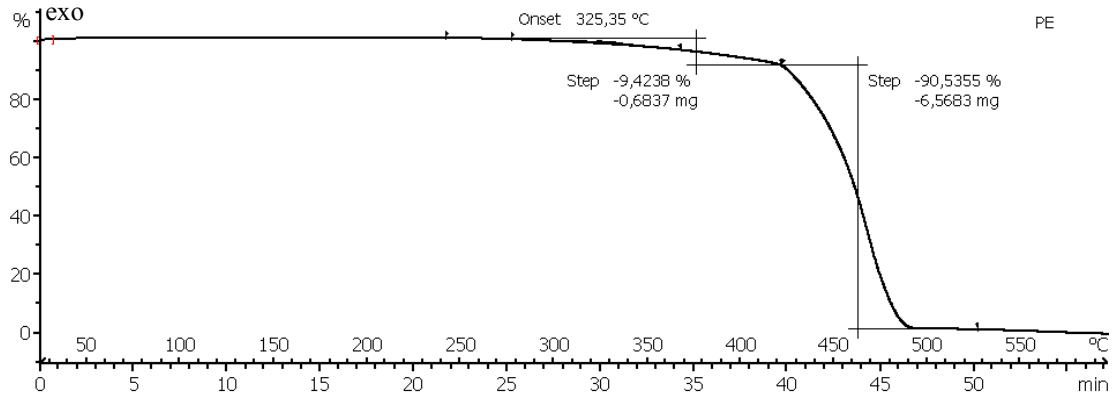

Fig. 1. TGA curves of sample as recorded in the temperature range 25-600^{0}C

PE can not be used as a material for achieving the necessary matrix to obtain the microcellular carbon, because in the normal atmosphere it oxidizes, decomposes into volatile components and the amount of carbon residue obtained is equal to zero.

Analyzing the TGA curve recorded for PP can be observed total mass loss (by ~ 100%) in the range 280-460^{0}C (fig. 2).

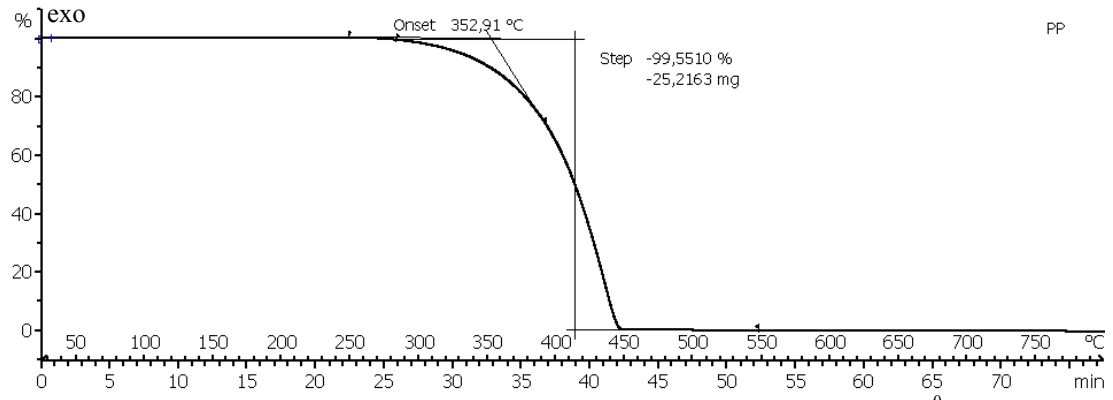

Fig. 2. TGA curves of PP sample recorded in the temperature range 25-800^{0}C

PP is a polymer which decomposes in a wide temperature range due to random chain scission leading to a large variety of gaseous products. The initial decomposition temperature T_i, when the thermal oxidative degradation process begins was found by TGA to be of 352.9^{0}C.

After analyzing the TGA curve recorded for PB-1, we observe a total mass loss (by ~ 100%) in the range 291-455^{0}C (fig. 3).

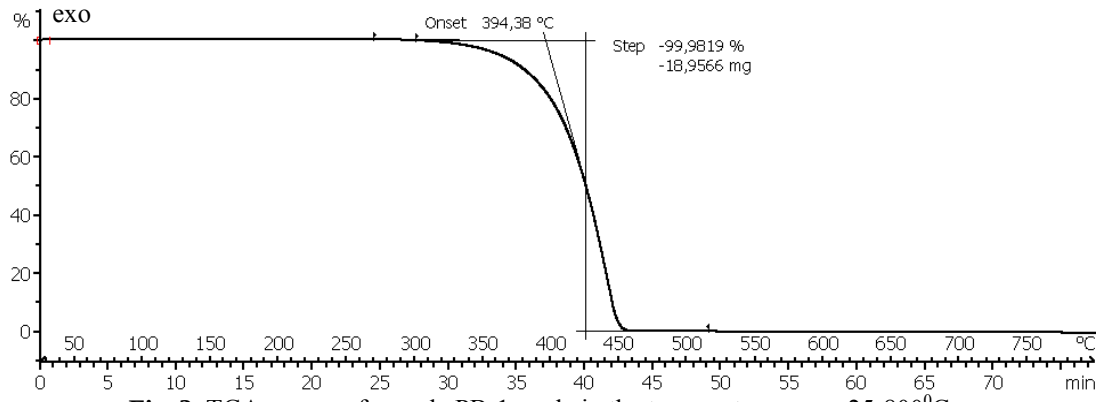

Fig. 3. TGA curves of sample PB-1 made in the temperature range 25-800^{0}C

The initial decomposition temperature T_i, when the thermal oxidative degradation process begins was found by TGA, at about ~394^{0}C.

Studying the TGA curve recorded for the PET, it can be observed a mass loss of ~ 90%, thus, the amount of carbon residue obtained is low (fig. 4).

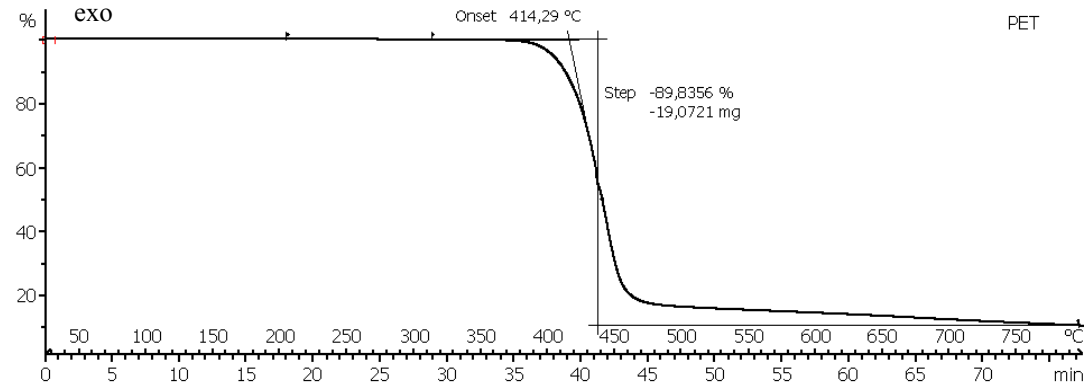

Fig. 4. TGA curves of the sample of PET recorded in the temperature range 25-800^{0}C

The initial decomposition temperature T_i, when the thermal oxidative degradation process begins, was found by TGA, at about ~414,3^{0}C.

After analyzing the TGA curve recorded for PBT, there is a mass loss of 93% between 322-600^{0}C, the amount of carbon residue obtained is low (fig. 5).

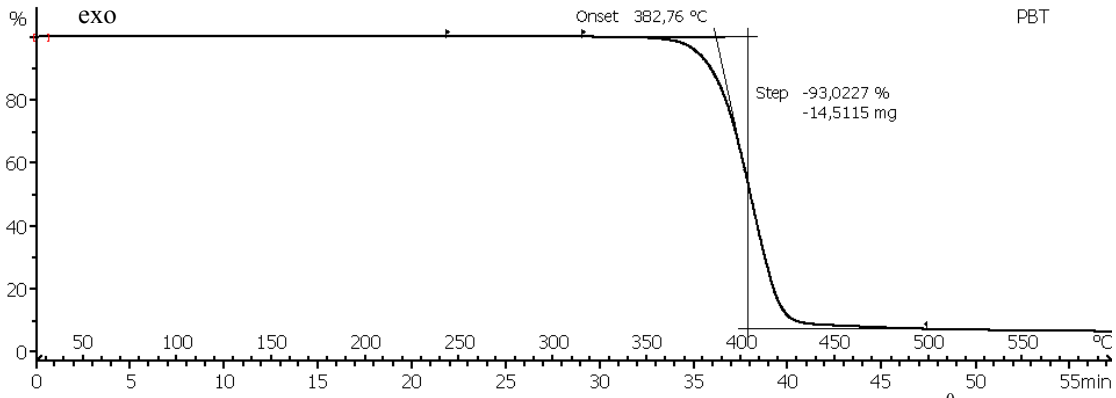

Fig. 5. TGA curves of sample PBT recorded in the temperature range 25-600^{0}C

The initial decomposition temperature T_i, when the thermal oxidative degradation process begins was found by TGA, at about ~382,7^{0}C.

TGA analysis concluded that PBT cannot be used as material to achieve necessary matrix to obtain microcellular carbon, because of the amount of carbon residue obtained is small.

Conclusions

In this paper, we study the thermal behavior of some polymers (polyethylene (PE), polypropylene (PP), polybutene-1 (PB-1), polyethylene terephthalate (PET) and polybutylene terephthalate (PBT)) in order to identify those able to be transformed into carbon materials, resulting in a small cell.

TGA analysis performed on the same polymers (PE, PP, PB-1, PET and PBT) followed to identify the quantity of carbon residue. Our results have shown that these polymers cannot be used to perform the matrix necessary to obtain the microcellular carbon because the amount of residual carbon obtained is negligible or small.

References

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Studiul analizelor termogravimetrice efectuate asupra unor polimeri cu potențial în dezvoltarea de materiale carbonice

Rezumat

În aceasta lucrare se studiază comportarea termică a unor polimeri – polietilena (PE), polipropilena (PP), polibutena-1 (PB-1), polietilentereftalat (PET) şi polibutilentereftalat (PBT) – cu scopul de a îi identifica pe cei capabili să conducă la obţinerea de material carbonic microcelular. Analizele termogravimetrice (Thermogravimetric Analysis-TGA) efectuate asupra acestor polimeri (PE, PP, PB-1, PET şi PBT) au urmărit stabilirea cantităţii de reziduu carbonic.