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UV spektral Analysis of Pirolyzis residues

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Introduction

During the process of anaerobic thermal degradation of organic materials (pirolysis) gas, liquid and solid products are formed. Solid residue of pirolysis of different polymers was investigated at different temperatures and heating programs. Extracts of the residues of pirolysis were produced with various polar solvents like water, methanol, and hexane. Looking at the characteristics of the spectra of extracts in UV range we found significant differences. The material characteristics of the starting polymers and the conditions of the pirolysis are both having specific effects on the examined spectras. For hydrocarbons, at the 200-400 nm range, mainly the molecules with conjugated double bond (molecules with delocalized Pi electron systems) are showing absorption. Supposing the uniform distribution of Pi electron systems, the shape of spectra was analyzed and modeled; the thermal fragmentation processes can be featured using simple theories of thermodynamics.

Series	Warm-up time	Temperature	Hold time
A	150 min.	400 ºC	60 min.
B	180 min.	450 ºC	90 min.

Materials and Methods

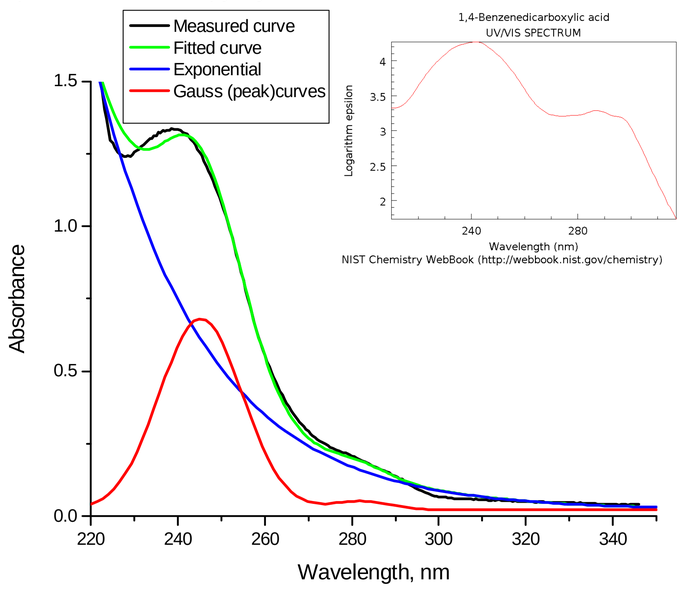
In our study six types of pyrolysis residues from polymeric materials were examined (ABS, Ultramid, Poliram, PET, Rubber, Celluloze). For the tests we weighted 5-5 g shredded polymer samples into test-tubes. The heat treatment was performed by the programmable furnace of the laboratory. The test-tubes with the samples were randomized in a wire basket and put in the furnace.

Each plastic samples were annealed in 9 repetitions, to the extracts which were made by 3 solvent, could be produced in 3 repetitions too. As a control, we annealed the solvents as well. We made the treatments with 2 types of temperature program.

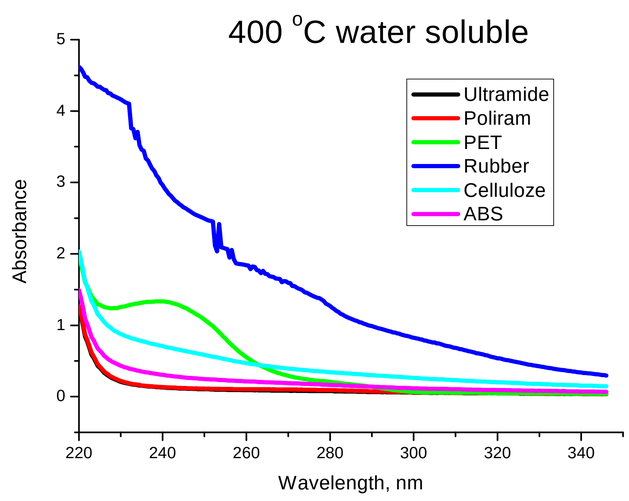
For keeping away the oxygen during the pirolysis we put 5 cm^3 distilled water into the test-tubes and to avoid the diffusion we used plugs, made of aluminum foil.

We made extracts from the cooled pyrolysis residues. The following solvents were used: methanol, gasoline and water. 5 cm^3 of solvent were put in each test-tubes contained pyrolysis.

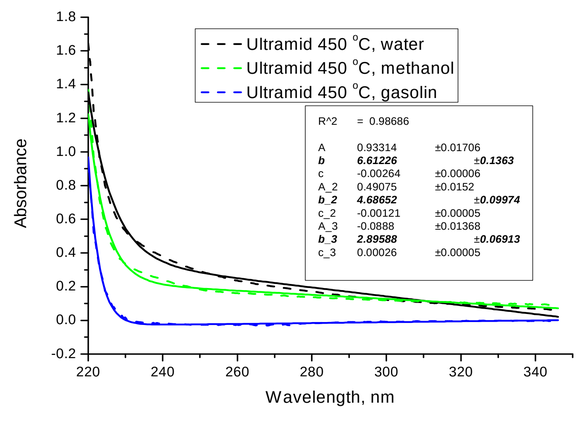
The spectrum of the PET pyrolysis residue's extract

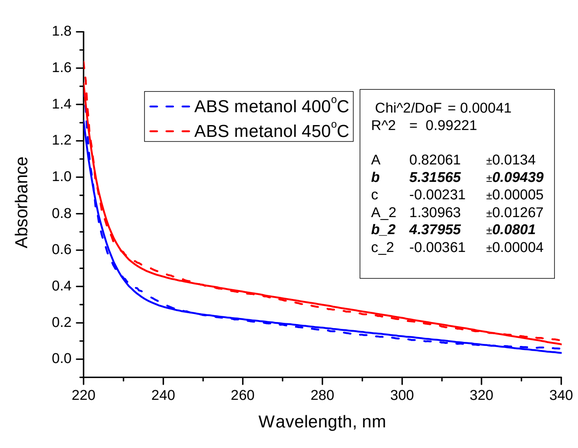


With the increasing wavelength the spectral curves are mostly exponential.

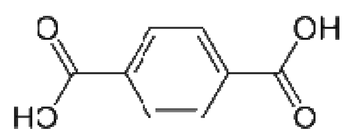


$$y = A + C \cdot x + e^{-\frac{x - x0}{B}}$$





Terephthalic acid



We defined the spectrum of the terephthalic acid as the sum of two Gaussian functions

$$y = y_1 + A_1 \cdot e^{-\frac{x}{t_1}} + \frac{A_2 \cdot e^{-\left(\frac{x - xc_2}{w_2}\right)^2}}{w_2 \cdot \sqrt{\frac{\Pi}{2}}} + \frac{A_3 \cdot e^{-\left(\frac{x - xc_3}{w_3}\right)^2}}{w_3 \cdot \sqrt{\frac{\Pi}{2}}}$$

	Value	Error
R^2	**0,9951**	
y_0	0.0	0.01
A_1	9518.5	2073.30
t_1	25.3	0.63
A_2	15.8	0.59
w_2	19.1	0.47
xc_2	**245.2**	0.16
A_3	0.5	0.00
w_3	13.2	4.00
xc_3	**282.0**	0.00

Conclusion

Molecule parts and functional groups containing some heteroatoms can also show absorption in this wavelength range, in their spectra, some absorption peaks of monomers can be found also. Optical spectroscopy of the pirolysis residue extracts is a simple and effective method. Therefore the UV spectroscopy could be suitable for statistical analysis of evolving complexes, and follow-up the process of pirolysis of varied molecules.

Acknowledgement

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MAGYARORSZÁG MEGÚJUL
A projektek az Európai Unió támogatásával valósulnak meg.