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Study of Ir-Spectra when Processing Recycled Polyethylene

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Currently, one of the most remarkable areas of polymer materials science in the world is the growing interest in the production of secondary materials by recycling polymer waste. The destruction of plastic waste is one of the most pressing problems of our time. Because during the production of all types of plastic products a certain amount of technological waste is generated. In particular, when processing polyethylene (PE), which belongs to the group of polyolefins, and various types of polymer composite materials (PCM), various technological wastes are generated. To correct this deficiency, various chemical additives are added to its composition.

Study of IR-spectra of recycled polyethylene waste In the conducted studies, a mixture of soapstock and dioctyl phthalate in a 1:1 ratio was used as a plasticizer from waste from the local oil industry to plasticize recycled polymer waste. Below are the results of studies conducted to study the IR-spectra of recycled PE waste (Fig. 1).

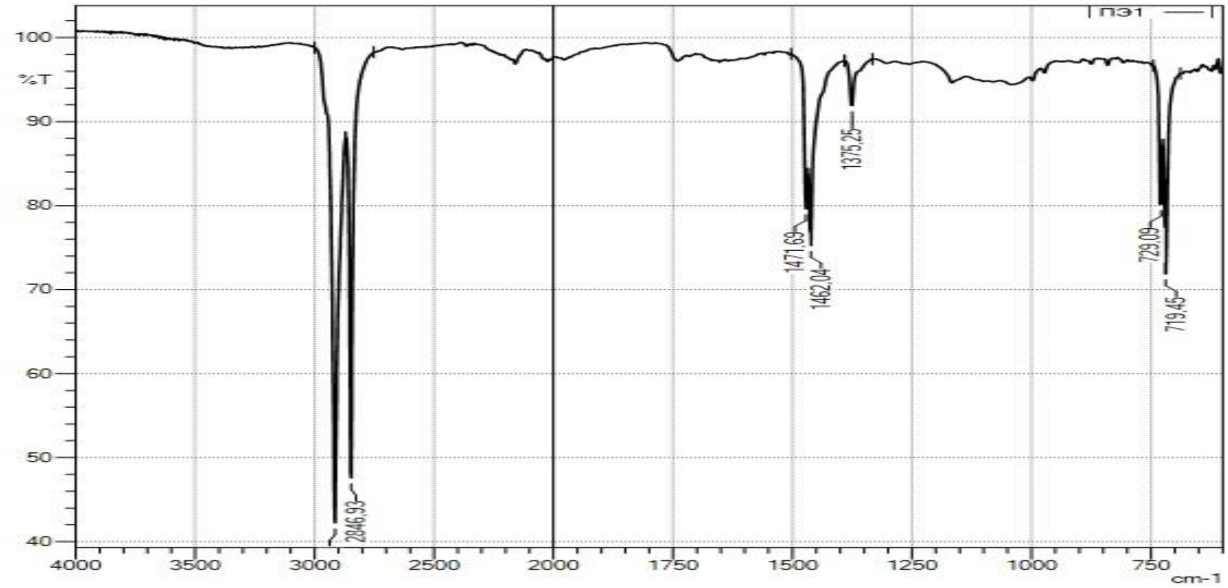

Fig. 1. IR-spectrum of secondary PE.

Table 1. Characteristic frequencies of secondary PE related to important groups of the IR-spectrum.

Nature of Vibration	Frequency, cm $^{-1}$	Intensity
PE ν_{CH2}^{as}	29 3 0.30	strong
PE ν_{CH2}^{s}	2846.93	strong
δ^{s}_{CH2}	14 62 , 04	average
PE Υ_{C-C}	7 1 9.09	weak

An infrared spectrum of the soapstock sample shown in Figure 2 was then obtained.

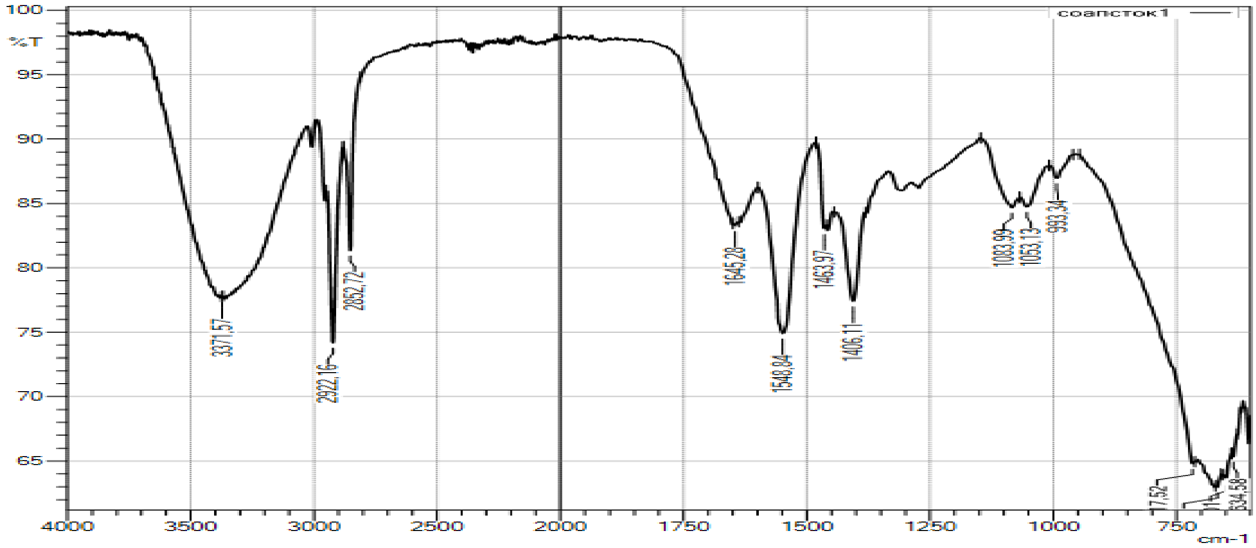

Fig. 2. IR-spectrum of soapstock

Table 2. Characteristic frequencies of soapstock belonging to important groups in the IR-spectrum.

Nature of Vibration	Frequency, sm^{-1}	Intensity
ν_{OH} (connected)	3371.57	strong, moderate
$\nu_{CH2}{}^{as}$	2922.16	strong
$\nu_{CH2}{}^{s}$	2852.72	strong, moderate
$\nu_{C=C}$	1645.28	average, weak
$\nu_{C=C}$ (double bond in the aromatic ring)	1548.84	average, weak
Δ_{CH} (aromatic)	1463.97	average, weak
d $_{OH}$	1406.11	average
$\nu_{so}{}^{as}$ (-C-O-H)	1085.99	average, weak
$\nu_{so}{}^{s}$ (-C-O-H)	1053.13	average, weak
δ_{CH} (alkene)	993.34	weak

An IR-spectrum of soapstock was obtained . In this table, the 2 groups CH_2, CH(aromatic), CH(alkene), C=C, CO, C=C(double bond in the aromatic ring), OH(linked) and other groups specific to soapstock are asymmetric and symmetrical. The values of valence fluctuations are given.

The infrared spectrum of a sample of soapstock with a mass of 1:0.3 with recycled polyethylene was obtained in Figure 3.

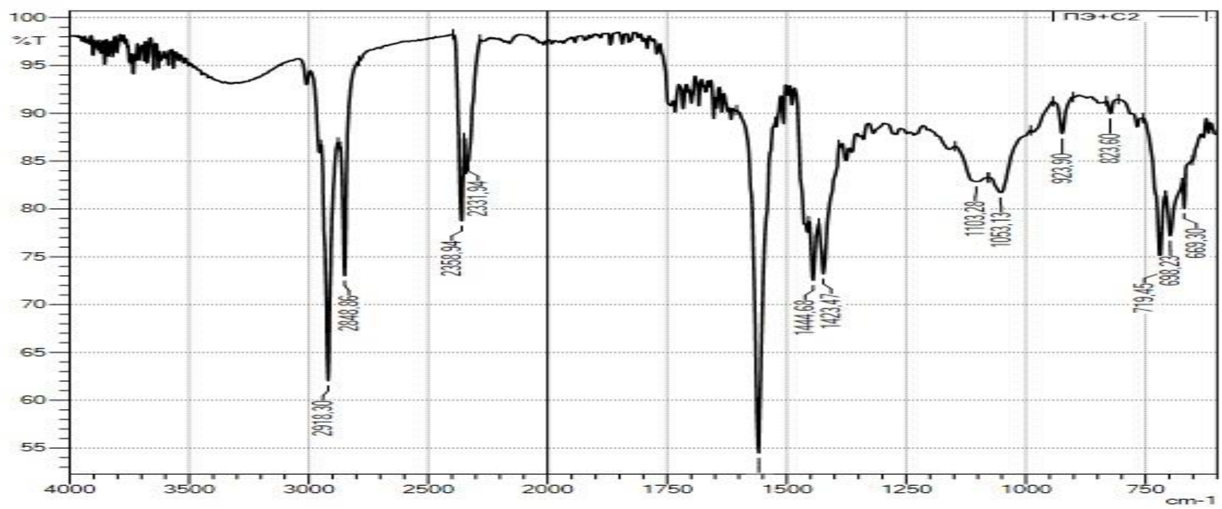

Figure 3. secondary PE + soapstock (0.3 MB) IR spectrum

Table 3. Recycled polyethylene + soapstock (0.3 MB) Characteristic frequencies related to important groups of the IR spectrum.

Nature of Vibration	Frequency, sm^{-1}	Intensity
PE ν_{CH2}^{as}	2918.30	strong
PE ν_{CH2}^{s}	2848.86	strong
soapstock $\nu_{C=C}$	1634.01	weak
soapstock $\nu_{C=C}$ (double bond in the aromatic ring)	1551.2	weak
PE δ^{s}_{CH2}	1444.68	average
soapstok δ_{OH}	1423.47	average
soapstok ν_{so}^{as} (-C-O-H) for groups	1103.28	weak
soapstok ν_{so}^{s} (-C-O-H) for groups	1053.13	weak
soapstock δ_{CH} (alkene)	923.90	weak
PE Y $_{C-C}$	823.60	weak
soapstock $\delta_{=CH}$	698.23	average, weak

In experiment 3, the IR-spectrum of recycled polyethylene + soapstock was obtained at 0.3 mb. When mixing soapstock with secondary PE in a ratio of 1:0.3, the values of asymmetric and symmetric stretching vibrations characteristic of the CH_2 group in PE (ν_{CH2}^{as}) range from 2920.30 sm^{-1} to 2848.86 sm^{-1} and symmetric vibrations (ν_{CH2}^{s}) It can be seen that batachrom is shifted from the region of 2846.93 sm^{-1} to the region of 2848.86 sm^{-1}. Similarly, the specific stretching vibration of the C=C double bond in soapstock ($\nu_{C=C}$) is from 1645.28 sm^{-1} to 1634.01 sm^{-1} and the stretching vibration of the specific double bond of the aromatic ring $\nu_{C=C}$ (aromatic double bond in the ring) completely shifts from 1548.84 sm^{-1} to 1551.2 sm^{-1}.

Therefore, the stretching vibrations characteristic of the OH group of soapstock (ν_{OH}) have a strong intensity in the region of 3371.57 sm^{-1}, a broad-shaped signal formed by a hydrogen bond, a bathochromic shift indicating the presence of a broad-shaped hydrogen bond with weak intensity at 3381.67 sm^{-1} appears through it can be seen that these changes in the macromolecule increase the interaction bonds (dipole-dipole, electrostatic and hydrogen bonds) between the molecules of polyethylene and soapstock raw materials.

Based on the above experimental results, we can conclude that the main reason for improving the physical and mechanical properties of polymer macromolecules during the processing of plasticized (1:0.3 m.b.) secondary polyethylene composite mixtures is the complete mixing of macromolecules filled with polymer and the formation of dipole-dipole, electrostatic , hydrogen bonding and physical effects can be seen by the changes in the peaks in the above spectra. A mixture of recycled polyethylene with soapstock and DOP 1:0.3 mb is the optimal working recipe that can be used for the production and use of various plasticized polymer composite products for technical purposes.

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