Supplemental Material to the article

"Anisotropy of the terahertz electromagnetic response of filamentous microstructures of a composite based on polypropylene with carbon nanofibers"

1. Results of studying THz transmission in filamentous microstructures based on polypropylene subjected to high-temperature stretching, but containing no carbon nanofibers. The filamentous microstructures based on polypropylene for THz test experiments were prepared using a technology similar to that described in the main text of the article, differing only in that carbon nanofibers were not introduced into these structures. The diameter of the filaments obtained was also of the order of 160 μm. The filaments were deposited on a KDB-10 crystalline silicon substrate and were located almost parallel to each other with a gap of about 600 μm between them. The diameter of the THz probe spot on the sample under study was about 4 mm. In this case, about 6 polypropylene filaments fell into the region of the spot of normally incident THz radiation.

Figure S1a shows the waveforms of THz radiation transmitted through a clean silicon substrate, as well as through a substrate with polypropylene filaments deposited on it at different orientations of the filaments with respect to the plane of polarization of the probe THz radiation. It can be seen that THz radiation with polarization along and across the filaments propagates in the investigated microstructure at the same speed, that is, there is no birefringence. It can also be seen that there is linear dichroism in such structures, but it is much weaker than in filamentous structures based on a polypropylene/carbon nanofiber composite, the results of which are presented in the text of the main article (comparison of the amplitudes of THz signals at the maximum of waveforms gives a difference in the values of linear dichroism more than 3 times).

Figure S1b shows the spectra of relative transmission $T_{\mathrm{str.+c-Si}}/T_{\mathrm{c-Si}}$ (here $T_{\mathrm{c-Si}}$ and $T_{\mathrm{str.+c-Si}}$ are, respectively, the amplitude THz transmission coefficients of a pure silicon sample and a silicon sample with the structure under study) for a filamentous microstructure based on stretched polypropylene with different orientations of the filaments with respect to the plane of polarization of THz radiation. As it can it be seen, the transmission spectra of such structures do not show resonance absorption at a frequency of about 1.8 THz, which is observed for filamentous microstructures based on a polypropylene/carbon nanofiber composite (see the text of the main article). Figure S1c also shows the spectrum of the degree of polarization of the amplitude transmission ρ_L, which characterizes the value of linear dichroism for a filamentous microstructure based on stretched polypropylene. It can be seen that the degree of polarization of the amplitude transmission does not exceed 20 % and has a smooth spectral dependence.

2. Results of studying THz transmission in filamentous structures based on polypropylene without stretching and containing no carbon nanofibers. We have also prepared test filamentous structures based on polypropylene, which does not contain carbon fibers and which has not been stretched. The diameter of the resulting filaments varied along their length in the range of 350–450 μm. The filaments were deposited on a silicon substrate and were located almost parallel to each other with a gap of about 600 μm between them. The probe THz radiation was additionally defocused so that about 6 filaments of the investigated material fell into the region of the radiation spot.

Figure S2a shows the waveforms of THz radiation transmitted through the silicon substrate, as well as through the substrate with polypropylene filaments deposited on it, with different orientations of the filaments with respect to the plane of polarization of the probe THz radiation.

From the presented data, it follows that THz radiation with polarization both along and across the filaments propagates in the structure under study at the same speed, that is, there is no birefringence. In addition, linear dichroism in such structures is much weaker than in filamentous structures based on a polypropylene/carbon nanofiber composite, the results of which are presented in the text of the main article. Comparison of the amplitudes of THz signals at the maximum of the waveforms shown in Fig. S2a and in Fig. 1 of the main text of the article shows that the spectrum-averaged value of linear dichroism in filamentous structures based on polypropylene without stretching and without carbon nanofibers is about 17 times less than in filamentous microstructures based on the polypropylene/carbon nanofibers composite.

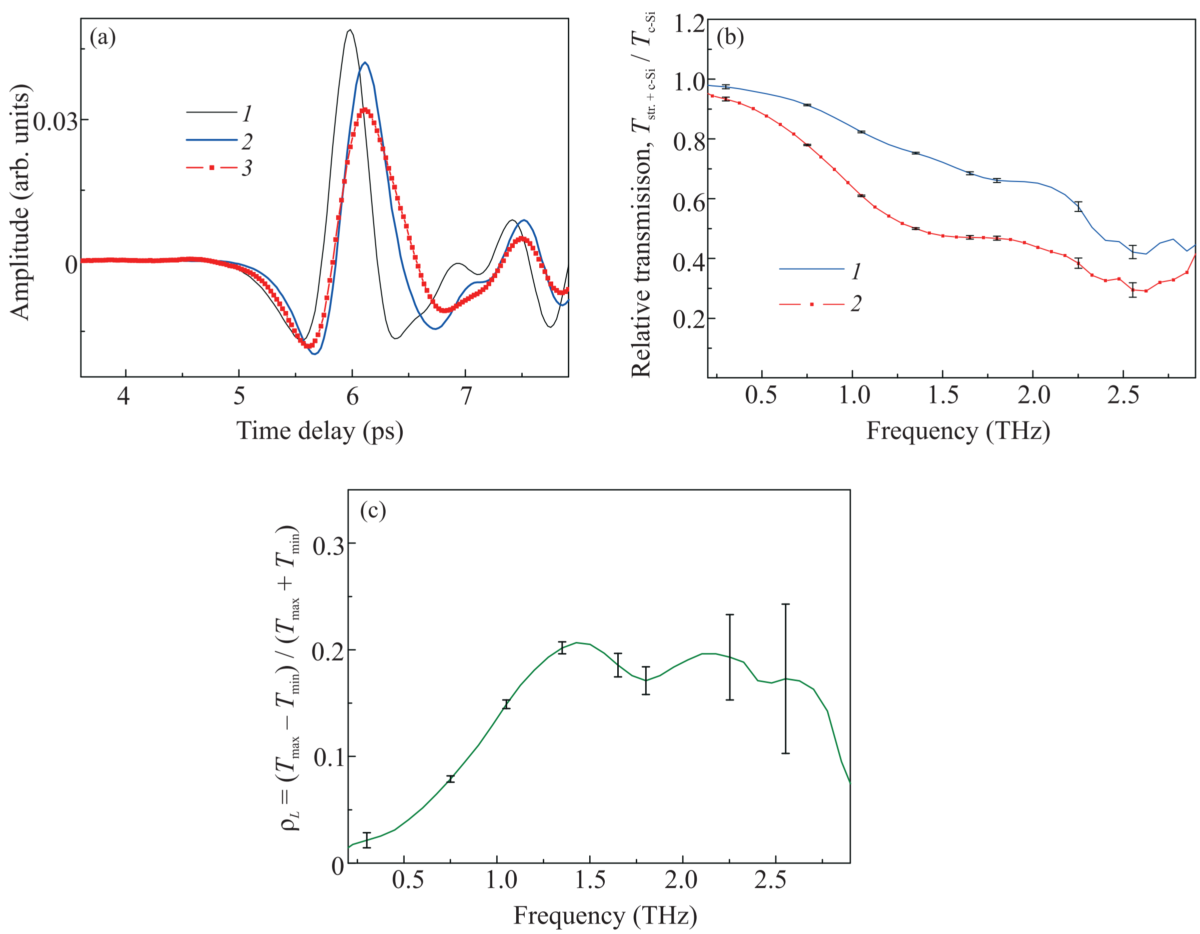

Fig. S1. (a) – Waveforms of THz radiation transmitted through the reference c-Si substrate (*1*) and through a substrate with filamentous microstructures based on stretched polypropylene with the orientation of the THz radiation polarization plane perpendicular (*2*) and parallel (*3*) to the filaments. (b) – Relative transmittance spectra $T_{\mathrm{str.+c-Si}}$; *1* – corresponds to the polarization of THz radiation perpendicular to the filaments, *2* - corresponds to the polarization parallel to the filaments. (c) – The spectrum of the degree of polarization of the amplitude transmission of the investigated filamentous microstructures based on stretched polypropylene

In Figures S2b and S2c, respectively, the spectra of the relative transmittance and the degree of polarization of the amplitude transmittance ρ_L for filamentous structures based on polypropylene (without stretching and containing no carbon nanofibers) are shown. The transmission spectra of such structures also do not show a resonance feature at a frequency of about 1.8 THz, which is observed for filamentous microstructures based on a polypropylene/carbon nanofiber composite (see the text of the main article). It can also be seen that, in the structures under study, the degree of polarization of the amplitude transmission does not exceed 10 % and becomes noticeable only in the 2.2 THz region.

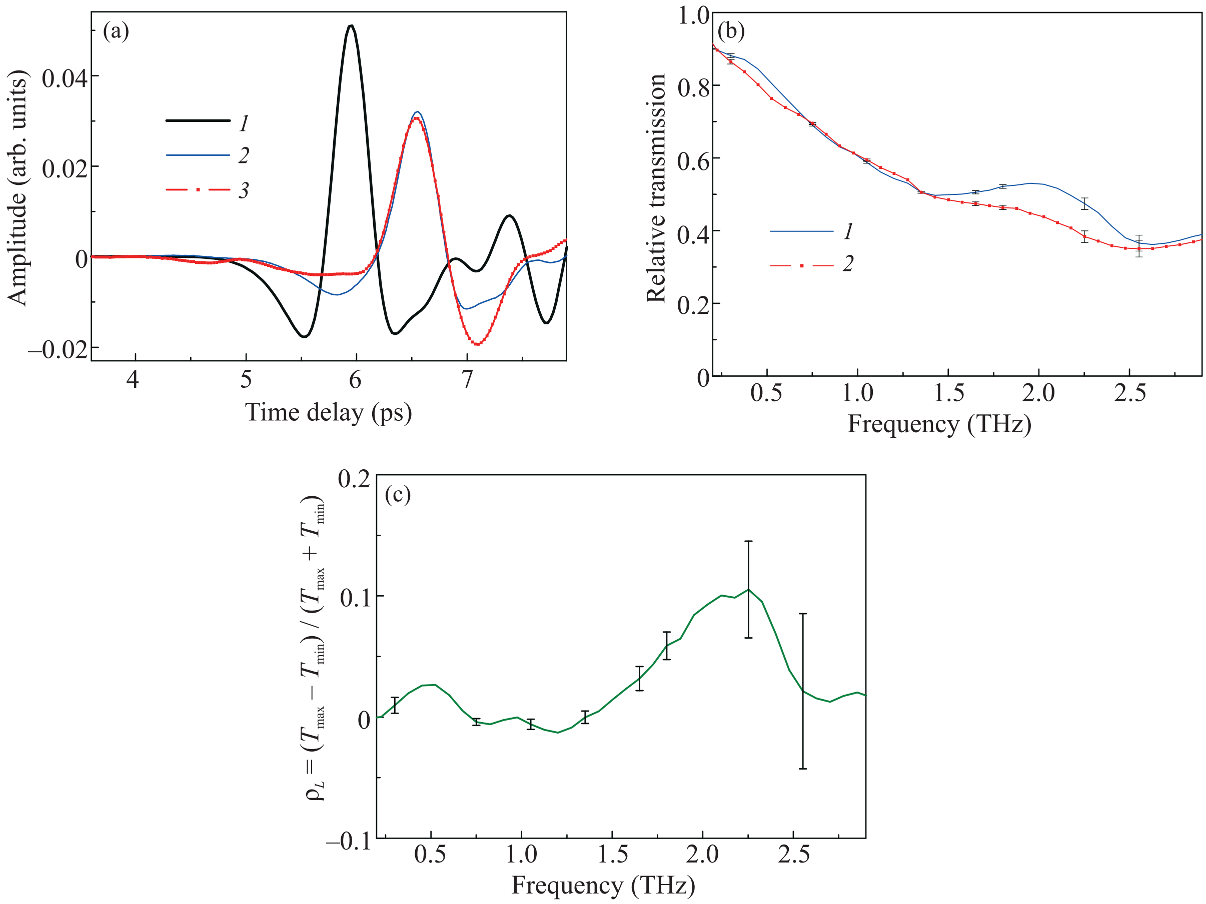

Fig. S2. (a) – Waveforms of THz radiation transmitted through the reference c-Si substrate (*1*) and through a substrate with filamentous structures based on polypropylene (without stretching and containing no carbon nanofibers) with the orientation of the plane of polarization of THz radiation perpendicular (*2*) and parallel (*3*) to the filaments. (b) – Relative transmittance spectra $T_{\mathrm{str.+c-Si}}/T_{\mathrm{c-Si}}$; *1* – corresponds to the polarization of THz radiation perpendicular to the filaments, *2* – corresponds to the polarization parallel to the filaments. (c) – The spectrum of the degree of polarization of the amplitude transmission of the investigated filamentous structures of polypropylene