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RESEARCH OF COMPOSITE POLYMER MATERIALS

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Abstract:

It is known that many fillers, including kaolin, make it possible to reduce the consumption of binding materials and reduce the cost of plastic, while at the same time the mechanical strength and some dielectric characteristics of composites can increase. The scientific concept has also been known since the early 70s, according to which fillers, usually mechanically mixed with other components, do not enter into chemical interaction with them.

Keywords: reflection, refraction, waves, magnetic structure, electromagnets.

Introduction

Object and methodology of research. In this work, using structural studies using EPR spectroscopic methods of kaolin-filled PS (polystyrene) composites, the following will be shown:

Firstly, contrary to prevailing ideas, the formation of a chemical bond between the components of composites in their interphase layers;

Secondly, the new magnetic properties exhibited by these composites will be analyzed. The last circumstance is a very important fact, since modern magnetic engineering requires new non-traditional materials with controlled properties. The very fact that it is possible to acquire some magnetism in PS films after filling with kaolin is not surprising. The fact is that kaolin, which is an aluminum silicate, always contains impurities that have more or less magnetism, for example, iron oxide, calcium and magnesium silicates, etc. Another important thing for us was whether it is possible to purposefully control the magnetic state of the prepared materials. In our specific case, ultrasonic dispersion for a certain time in a solution of the polymer in benzene followed by hot pressing of the mixed components was chosen as the dispersion of kaolin particles in the PS binding medium [1]. It is convenient to begin the analysis of the structural and macroproperties of composites obtained in this way with the interpretation of ESR spectroscopic studies. The result of an ESR study in air at room temperature for PS filled with kaolin in an amount of V1 = 0.06 is presented in Figure 1. The results of experimental and calculated data on paramagnetic parameters for this and other composites are presented in Table 1.

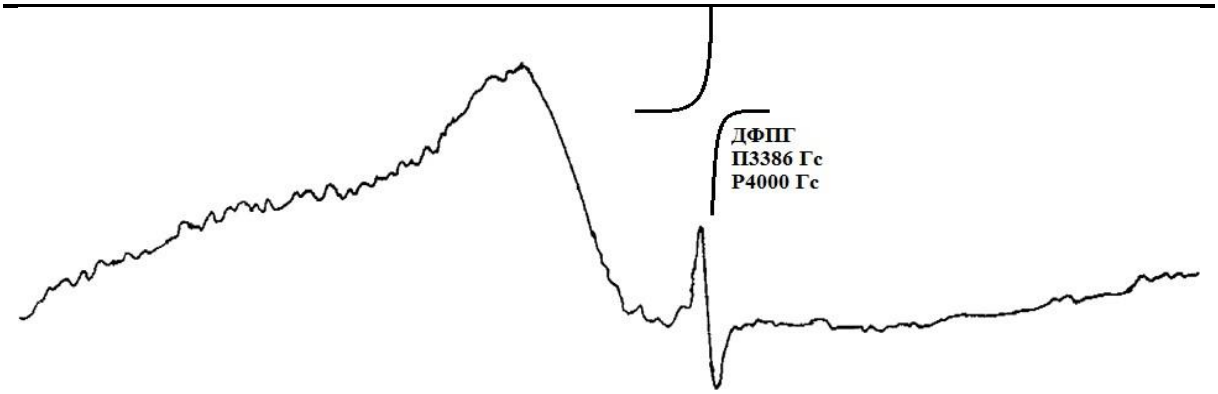

Figure 1. EPR spectrum of the PS+kaolin composite (0.06)

Methods

As can be seen from Figure 1, against the background of a general and fairly wide (ΔHPP=800 Oe) signal, two independent and very different in width (ΔHPP=320 Oe and ΔHPP=20 Oe) singlet signals stand out. Judging by the large width, by the value of the resonating magnetic field (H0x=3048 Oe) and by the fact that the quantities of PMC (paramagnetic centers) from this particular signal have a direct correlation with the concentration of the filler, we can assume the inorganic nature of the PMC responsible for the signal with ΔHPP= 320 Oe. Whereas a signal with ΔHPP=20 Oe with a resonating magnetic field (H0x=3048 Oe) is more likely to be of an organic nature. This assumption can also be supported by the fact that the amount of PMC decreases with increasing content of filler V1 (Table 1). The signal of organic origin does not change its EPR linewidth with a change in the amount of filler, which gives grounds to assume that the nature of the PMC from this component is the same for all the studied composites. The decrease in HPP and the increase with increasing filler concentration can be interpreted in favor of the possibility of a certain connection between these individual PMCs [1; 49 pages].

Sapphire (Al2O3) or silicon oxide (SiO2) themselves cannot be responsible for the left-handed component of the EPR signal in our experiments. Most likely, Fe + is responsible for the manifestation of this component of the EPR signal, because it is valence iron that can produce such a wide EPR line at room temperature [2; 109 pages]. If this is indeed the case, then it is very important to clarify the question of what environment this iron signals in. A comparative analysis of our results shows the following result. This signal is not a consequence of the manifestation of Fe3+ paramagnetism, neither in the Si environment nor in SiO2. The first is possible at microwave frequency 8.4 GHz only at a temperature of 2ºK. According to [3; 672 pages] Fe+ in SiO at room temperature exhibits an EPR signal with two characteristic spin Hamiltonians, whereas in all our experiments only one spin Hamiltonian is identified. Further, the left component of the overall EPR signal of composites cannot be a consequence of paramagnetism either in the environment, only Al2O3, or in any combination, only Fe:Al. According to studies, ESR signals for the following combinations Fe:Al=80; 200 and 300 appears only at very low temperatures - 4ºK; 90ºK and 20ºK temperatures.

Results

Table 1. Concentration dependence of some paramagnetic parameters of PS+kaolin composites

V_1	a, E	Д, MHz	Д, sm^{-1}	ΔH_{PP}, E	ΔH_{PP1}, E	ΔH_{PP2}, E	(Im'/m)1	(Im'/m)2
0,02	945	2646	0,0882	1250	550	20	1,05	1,85
0,04	450	1260	0,042	800	300	20	1,04	1,45
0,06	410	1148	0,0382	800	320	20	2,33	1,46
0,08	467	1307,6	0,0435	720	400	20	5,9	1,05

The spin Hamiltonian 0.0882 cm^{-1} from our experiment for the case of PS with kaolin V_1=0,02 practically coincides with 0.083 cm^{-1} Fe^{+} in Al $[(CH_3CO)_2CH_3]_3$ at room temperature.

Discussion

Fe_3^{+} in natural sapphire at room temperature exhibits an EPR signal with two spin Hamiltonians, neither of which corresponds to the data from our experiments (Table 1). This signal is also not a consequence of Fe^{+} in TiO (may be present in kaolin in the range of 0.4-1.2%), because in this combination the EPR signal has three spin Hamiltonians, none of which correspond to our data. And finally, this signal cannot be a consequence of Fe3+ in CaO (may be present in kaolin within about 0.8%), since the EPR signal from such a combination should appear at a liquid nitrogen temperature of 77ºK or at even lower temperatures, for example, at 20ºK.

Conclusion

If such a coincidence is not a random event, then it can:

Firstly, to point out the events that are so significant from the point of view of the formation of new compounds that occur due to the ultrasonic dispersion of filler particles in the PS binding medium;

Secondly, to become a point of contention for further explanation of all structural features emerging from EPR experiments of these composites.

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