METHODS OF POLYMER MATERIALS MODIFICATION THROUGH CARBON NANOSTRUCTURES

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Introduction

One of the perspective lines of investigation on producing the materials with the given properties is the development of polymer materials modified by carbon nanostructures (fullerens and nanotubes). In this case the strength, thermal stability, gas penetration, conductivity and other important operation polymer properties can be significantly changed [1-3].

Results and discussion

There are two principle ways of fullerene incorporation into polymer composition: by means of covalent bond and by the complex one. Fullerene incorporated covalently into polymer matrix restructures it that is used when composing the new multifunctional polymer structures. Non- covalent fullerene binding with polymer material can lead to production of complexes with modified properties. Carbon nanotubes are incorporated into polymer composition by mixing and uniform dispersing at micron level.

Such methods of incorporation allow classifying C_{60}, C_{70} fullerenes and other molecular nanostructures as stabilizators and inhibitors, that is, the agents controlling the running of chemical processes in polymer. Carbon nanotubes and nanofibers are used as fillers, that is, the materials firstly affect thermal deformation and other physicochemical polymer characteristics.

We have investigated the C_{60} fullerene additive affect on the thermal, radiative, optical and mechanical properties of polymers on the basic of polymethylmethacrylate, polystyrene and polyethylene. Technique of synthesis of investigated composites consisted in mixing in a definite proportion of fullerene solution in organic dissolvent and polymer that led to non-covalent binding of fullerene and polymer (on the optical spectra there are seen the absorption bands in ultra-violet and visible range characteristic for C_{60} fullerene).

The results of investigations showed, that fullerenes are the inhibitors of chain radical reactions of thermal and thermo-oxidative destruction of polymers. Fullerenes slow the thermo-decay of polymethylmethacrylate up to the temperature 340°, polystyrene up to the 380° and polyethylene up to the 360°. Mechanism of fullerene inhibition effect consists in the interaction between free radicals and fullerenes with production of thermally stable compounds. Comparison of fullerenes with known organic anti-oxidant (amins, phenols, phosphor and sulphur containing compounds) that can inhibit thermo-oxidative polymer destruction only up to 270-290°C, shows that fullerenes have the advantages at the temperatures of polymer destruction more than 300° C.

Study of polymers irradiated by electrons (irradiation doses were 5, 10 and 30 Mrad, the energy was from 8 to 9 MeV), using the methods of differentially-thermal, thermo-gravimetric, X-ray-structural analysis, optical spectrometry and testing on tension, demonstrated that including of C_{60} fullerene into the compositions mentioned increases the temperature of PMMA destruction beginning by 20-25° C; it lowers the rate of thermo-oxidative destruction in 4-4.5 times for PMMC and in 1.4-2.0 times for PS; it increases the strength characteristics of PMMA and co-polymers; it changes the film transmission in ultra-violet and visible range and does not change the transmission in the neighbour IR-region; it leads to stabilization of PMMA, PS and co-polymers molecular mass; it does not make noticeable changes into film phase composition.

The results obtained show the increase of polymer stability when adding the C_{60} fullerene, that can contribute to improving the operation characteristics of materials produced on their basic and to increasing their life time.

Conclusion

The results of investigation of composite properties point to increase of thermal and radiative stability, rupture strength of modified polymers.

References

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