INVESTIGATION OF LOW TEMPERATURE RADIATION POLYMERIZATION OF VINYL MONOMERS WITH FULLERENE C_{60} BY OPTICAL SPECTROSCOPY METHOD

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Introduction

Fullerenes and their water soluble derivatives are of great deal interest for scientific research due to their biological activity [1]. Therefor, the problems of modification and functionalization of nanomaterials to obtain their water soluble derivatives are very challenging task. In present work we have investigated low-temperature γ induced copolymerization of vinyl monomers such as acrylamide and acrylic acid with fullerene C_{60} to obtain their water soluble polymers containing fullerene.

Results and Discussion

Polymerization took place during heating of γ-irradiated at 77K mixtures of 15% solution of acrylamide or acrylic acid in ethyl alcohol with solution of fullerene in toluene. So, polymerization has performed in glass matrix at temperatures a little higher than the temperature of vitrification of alcohol in the regime of overcooled liquid (T_g =90 K). The approach does allow to carry out the polymerization at the temperatures for 100K lower than those if polymerization would have carried out in own matrix of monomers. In these conditions the mobility of monomer molecules is rather high in order to reach the active center and at the same time the mobility of propagating macroradicals is not enough for recombination [2]. All above said leads to high efficient polymerization. Actually the polymerization yield for pure polyacrylamide (PAA) is around of 98 % while for the polymerization of the mixture of acrylamide in alcohol with fullerene in toluene is around of 70%. The portion of fullerene did not participate in polymerization was eliminated by its double extraction by toluene from water solution of polymers obtained. The fullerenecontaining polymers of acrylamide (FPAA) or acrylic acid (FPAAcid) turned out to be soluble in water and in their optical absorption spectra demonstrated an absorption in the region from 280 nm up to 700 nm whereas in absorption spectra of these pure polymers (PAA) or (PAAcid) there is not any absorption in this range (Fig.1, 2).

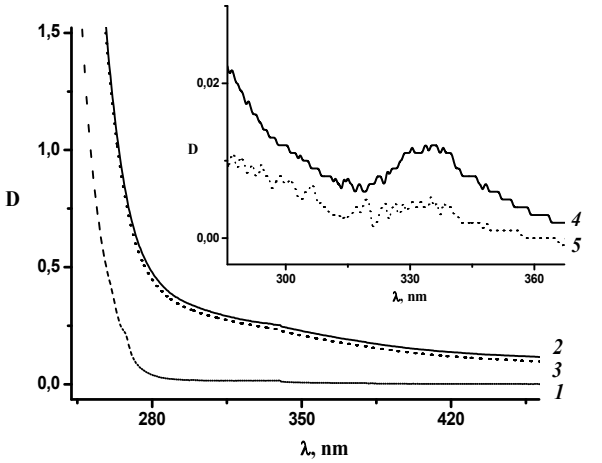

Fig.1. Optical absorption spectra of water solutions of: *1* – PAA (30 мг/мл); *2*– FPAA (30 мг/мл) before extraction of free C_{60} or its complexes by toluene; *3* – FPAA after double extraction of free C_{60} or its complexes by toluene; *4* – optical absorption spectrum of first extract by toluene; *5* – optical absorption spectrum of second extract by toluene.

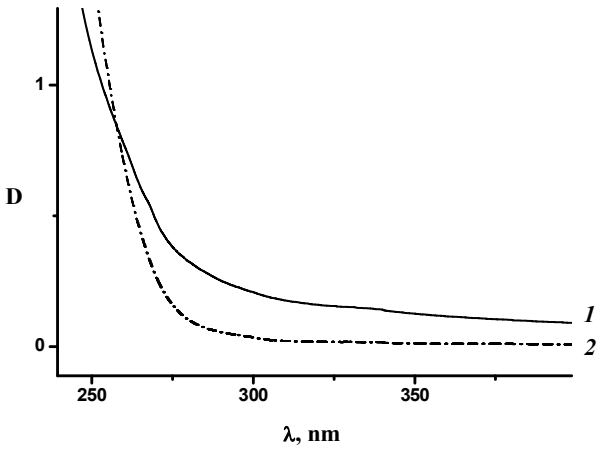

Fig.2. Optical absorption spectra of water solutions of: *1*- FPAAcid; *2* – PAAcid.

Fullerene containing polymers after elimination of water are represents the yellow colored films. Under hundred-fold enlargment it can be seen that fullerene containing polymers aggregate into both globes of diameter around 30 micron and into graft dendritic shapes (10× 30 micron). The films are easy dissolved in water again. By so doing they

remain all features of optical absorption spectra, that is unstructured absorption from 280 nm to 700 nm characteristic for covalent bounded fullerene.

The loss of structure in optical bsorption spectra can occur due to formation of branched polymer [3] (may be star shaped) where fullerene molecule is a center of branching with strongly transformed electron structure because of its possibility to attach a few radicals due to its electron deficit natu re [4]. Other reason for the structure loss in spectra can be fullerene's tendency to aggregation [5].

Conclusion

Thus, water soluble polymers of acrilamid and acrylic acid containing covalent bounded fullerene are obtained. These products demonstrate in the optical absorption spectra the unstructured gradually decreasing absorption in the region from 240nm to 700nm characteristic for covalent bounded fullerene. The loss of structure in absorption spectrum characteristic for free fullerene apparently due to formation during copolymerization of branched polymer where fullerene molecules are the centers of branching. In this case electron structure of fullerene molecule should be strongly transformed leading to changes in optical absorption spectra. Other reason for this may be aggregation process to which fullerene molecules are very ready.

References

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