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Luminescent Properties of Nanocomposites on the Basis of Isotactic Polypropylene and Zirconium Dioxide Nanoparticles

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Abstract

At the paper studied luminescent properties of nanocomposites on the basis isotactic polypropylene and zirconium dioxide nanoparticles. Shown that change of nanocomposite colour and maximum amplitude of UV spectres depend on ZrO_2 nanoparticles sizes in polypropylene. Found that mean-square roughness of PP +1% ZrO_2 composition surface in dependence of cooling rate β changes, i.e. for the samples at regime β_1=20 deg/min the roughness is 40-60 nm, whereas for the samples prepared at β_2=2 deg/min the roughness is 150-220 nm. Shown that polypropylene matrix works as chemically stable preservative of nanoparticles, preserving its spectral peculiarities. Sufficiently strong interphases interactions between PP matrix and ZrO_2 nanoparticles change its luminescent properties.

Keywords: Nanocomposite; Polypropylene; Zirconium dioxide; Photoluminescence

Introduction

Polymeric nanocomposite materials, composed of two or more phases, require the development of physical and chemical basis of preparation of new active elements by means of modification of its structure and properties. These materials combine the positive properties of individual components of composite and acquire photo luminescent properties with high physic-mechanic characteristics [1-3]. Nanocomposites have got the unique properties, caused not only by too little sizes of metallic and semiconductor nanoparticles, but also by peculiarities of polymeric matrix structure. The polymeric matrixes allow organization of nanoparticles into supramolecular structures, which considerably increase the extraordinary properties of nanoparticles [4-5].

In the present work have been studied luminescent properties of nanocomposites on the basis of isotactic polypropylene and zirconium dioxide nanoparticles.

Experimental Part

As a polymeric matrix the powder of isotactic polypropylene with grain size 0.5-1.0 mcm, was used. The filler were nanoparticles of zirconium dioxide ZrO_2 with size 21 nm, stabilized by 3% of yttrium oxide (Y_2O_3).

Synthesis of nanocomposites of PP+ZrO_2 was carried out by introduction of ZrO_2 nanoparticles into the polymeric solution. Initial powder of isotactic with grain size 0.5-1.0 μm was solved in toluene at 120°C. The crystallization of polymer around zirconium dioxide nanoparticles and formation of large agglomerates without uniform distribution of nanoparticles in polymer solution was observed at immediate addition of nanopowders. This is explained that nanoparticles perform the centres of germ formation [6]. For uniform distribution of nanoparticles in polymer solution the nanopowders of zirconium dioxide was preliminary wet in toluene at light heating. Then the mixture was added to polymer solution and intensively stirred in 1 hour. The formed blend of polymer and zirconium dioxide nanoparticles was poured in Petri dish and dried at ambient in 24 hours in the air. The samples of nanocomposites PP+ZrO_2 with various volume content of ZrO_2 were prepared by hot pressing method at melting point of PP and pressure 10 MPa with further cooling till room temperature with rate β_1 = 20 deg/min and β_1 = 2 deg/min. The analyses of microstructure of samples were performed on optical microscope Motic AE 30/31. The morphology of nanocomposites, including distribution of zirconium dioxide nanoparticles in polymeric matrix was studied by scanning probe microscopy (AFM INTEGRA PRIMA).

The luminescent properties of nanocomposite films were performed on spectrofluorimeter Varian Cary Eclipse. The absorption spectra were performed on spectrophotometer SF Perkin-Elmer at 200-700 nm. All measurements were carried out at ambient temperature.

Result and Discussion

UV spectroscopy analysis of nanocomposite PP+ZrO_2 was carried out for study of ZrO_2 formation in polypropylene. Absorption spectra were performed on spectrophotometer Perkin Elmer, USA. The measurements were taken at ambient. The Figure 1 presents the absorption spectra of pristine polypropylene and nanocomposites

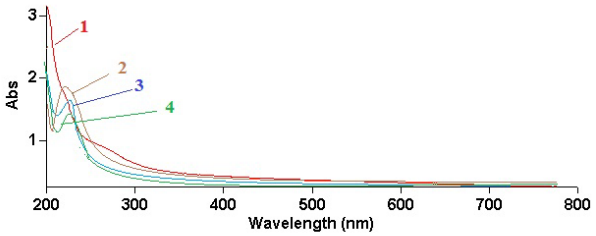

Figure 1: UV spectra of nanocomposite PP+ZrO_2 1. PP, 2. PP+1% ZrO_2, 3. PP+3% ZrO_2, 4. PP+5% ZrO_2.

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$PP+ZrO_2$ with different ZrO_2 volume content.

As it shown in Figure 1 the intensity of observed absorption at 235 nm change with various concentration of ZrO_2 in nanocomposite was found that increasing of nanoparticles concentration led to colour change of nanocomposite. The change of nanocomposite colour and UV spectra intensity is connected with increasing of ZrO_2 nanoparticles sizes in polypropylene.

The optic microscopy method performed the study of the surface of nanocomposite $PP+ZrO_2$, at various concentration of ZrO_2 and different temperature-time regime of crystallization of nanocomposite melt.

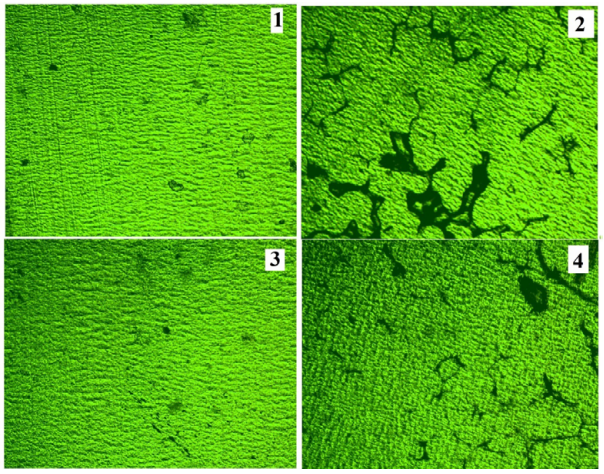

Figure 2: Microstructure of nanocomposite on the basis of polypropylene and zirconium dioxide prepared at regimes β_1=20 deg/min (1, 3) and β_2=2 deg/min (2, 4). 1. PP+1% ZrO_2, 3. PP+3% ZrO_2, 2. PP+1% ZrO_2, 4. PP+3% ZrO_2.

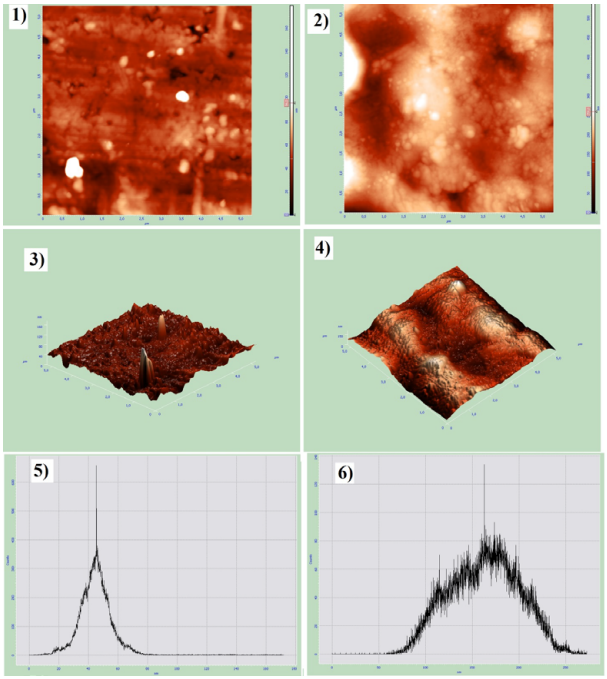

Figure 3: AFM images of PP+1% ZrO_2 nanocomposite prepared at regimes with cooling rate β_1=20 deg/min (1,3,5) and β_2=2 deg /min (2,4,6).

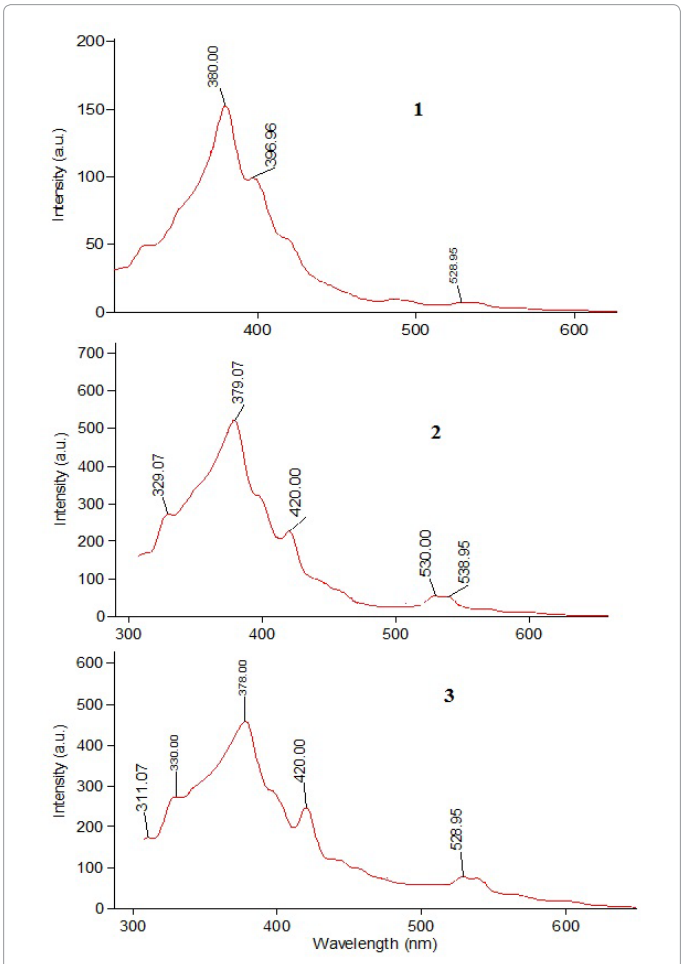

Figure 4: Luminescent spectra of nanocomposite $PP+ZrO_2$, Em_ex 270_ 1) PP+1% ZrO_2, 2) PP+3% ZrO_2, 3) PP+5% ZrO_2.

At Figure 2 shown the microstructure of nanocomposites $PP+ZrO_2$ prepared at various concentration of ZrO_2 and different temperature-time regimes β_1=20 deg/min and β_2=2 deg/min. Optic microscopy study of nanocomposite reveal the dependence of morphology and structure elements of nanocomposite on various concentration of ZrO_2 and different temperature-time regime of crystallization.

At Figure 3 shown AFM images of PP+1% ZrO_2 nanocomposite prepared at regimes with cooling rate 20 deg/min and 2 deg/min. AFM study of contour of nanocomposite samples PP+1% ZrO_2, prepared at various different temperature-time regime of crystallization revealed changes of structural elements on the surface of composites samples PP+1% ZrO_2. 2D and 3D image of nanocomposite prepared at different temperature-time regime of crystallization demonstrate the change of contour of samples, i.e. the sizes of structural elements with increasing of cooling rate reduce. At picture 3 shown the analysis of surface and histogram of elements values of nanocomposite PP+1% ZrO_2 images, prepared at different temperature-time regime of crystallization.

Shown that mean-square roughness of PP +1% ZrO_2 composition surface in dependence of β changes, i.e. for the samples at regime β_1 = 20 deg/min the roughness is 40-60 nm, whereas for the samples prepared at β_2 = 2 deg/min the roughness is 150-220 nm.

Have been studied photoluminescent spectra of $PP+ZrO_2$ nanocomposite prepared at various concentrations of ZrO_2

nanoparticles. At picture 4 presented photoluminescent spectra of nanocomposite 1) PP+1%ZrO_2, 2)PP+3%ZrO_2, 3) PP+5%ZrO_2. The maximums of luminescence observed at 330 nm, 380 nm, 400 nm, 420 nm and 538 nm.

Exiting of luminescence for given wavelength is connected with optical passages between valence zone and conductive zone shown that increasing of zirconium dioxide concentration led to increasing of intensity at 330 nm, 420 nm, 530 nm, 538 nm. The intensity of luminescence depending of concentration changes with extremum, i.e. the maximum luminescence is observed at 3% volume concentration. The analysis of prepared nanocomposites revealed that increasing of ZrO_2 nanoparticles concentration in PP and rise of its specific surface led to increasing of interphases interactions between components of nanocompositions. Increasing of interphases interactions led to binding of nanoparticles to polymer macromolecules and as sequence increasing of luminescence intensity (Figure 4).

Conclusion

These results also demonstrate that intermolecular interactions in photoluminescent active environment considerably influence on its spectral characteristics. From these experimental results can be concluded that polypropylene matrix works as chemically stable preservative of nanoparticles, preserving its spectral peculiarities, as well as there are sufficiently strong interphases interactions between PP matrix and ZrO_2 nanoparticles that change its luminescent properties.

References

1. Badamshina ER, Gafurova MP (2008) Modifying the properties of polymers by doping C_{60} fullerene. Journal Macromolecular compounds Ser A 50: 1572-1584.
2. Vossmeyer T, Katsikas L, Giersig M, Popovic I (1994) J Chem Phys 98: 7665-7673.
3. Maharramov A, Ramazanov M, Saboktakin MR (2013) Advanced Nanocomposites Types, Properties, and Applications. Nova Publisher 334.
4. Maharramov AM, Ramazanov MA, Hajiyeva FV (2014) Structure and dielectric properties of Nanocomposites on the basis of high-density polyethylene and lead sulphide. J Chalcogenide Letters 11: 175-180.
5. Maharramov AM, Ramazanov MA, Alizade RA, Asilbeyli PB (2013) Structure and dielectric properties of nanocomposites on the bas of polyethylene with Fe_3O_4 nanopatricles Digest. Journal of Nanomaterials and Biostructures 8: 1447-1454
6. Magerramov AM, Ramazanov MA, Hajiyeva FV, Guliyeva VM (2013) Investigation of structure and electrophysical properties of nanocomposite materials on the basis of zirconium dioxiden in isotactic polypropylene matrix. Journal of Ovonic Research 9: 133-141