LUMINESCENT PROPERTIES OF BIONANOCOMPOSITES LDPE + x vol.% FS

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In this work, the effect of luminescence in nanocomposites LDPE + x vol.% FS and LDPE + x vol.% FS + y vol.% Fe is studied. The experiments were carried out in a Cary Eclipse spectrofluorimeter. It was found that at wavelengths of 400-800 nm from all samples only 7 vol.% FS and 7 vol.% FS + 3 vol.% Fe samples have the best luminescent properties and can be widely used in solving practical problems.

Keywords: luminescence, nanocomposites, wavelength, intensity, spectrum
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INTRODUCTION

Recently, great attention has been paid to the study of materials of biological origin and composites with their participation. This is because fish skin is covered in scales; the presence of unpaired fins prevents the rotation of the fish around its axis, carry out translational movement, and paired fins provide balance and turns; the lateral line provides the sensitivity of the direction and the speed of the water flow [1-3]. In addition, fish skin protects the body from harmful environmental influences, and is involved in metabolism. Salts, oxygen, water and other substances are released and absorbed through it. Nerve endings are located on the skin, thanks to which it can perform the function of sensitive organs. The surface of the outer layer is porous. The scales have different sizes depending on the location. According to the data [4-5], fish scales consist of natural polymers - collagen. Collagen is a natural polymer belonging to the group of scleroproteins. The primary structure of collagen is a polypeptide chain consisting of alternating amino acid residues. Unlike other proteins, hydroxyproline, proline and glycine predominate in collagen, and hydroxyproline is a specific marker of collagen, since it is not found in any other proteins.

The purpose of this work is to study the luminescence spectra of fish scales and bionanocomposites filled with fish scales.

EXPERIMENTAL TECHNIQUE

Studies of the luminescent properties of fish scales and biocomposites filled with fish scales were carried out using a Cary Eclipse spectrofluorimeter. The device is universal for studying the spectral properties of samples of different nature. The device is focused on use in biological applications and in materials science. The excitation source is a pulsed xenon lamp, rated at 80 flashes per second, 75 kW equivalent peak power. The focusing optics is a Schwarzschild collector. The Czerny-Turner design controls the monochromators and the horizontal slit. There are six selectable slots: 1.5, 2.5, 5, 10, 20, 10 mm. Eclipse includes 2 monochromators and can be scanned independently by each of the monochromators. If an excitation monochromator is fixed and scanned with an emission monochromator, an emission spectrum or often called a fluorescence spectrum is obtained. The emission spectrum carries information about the molecular structure and the nature of the material. The shape of the fluorescence spectrum does not depend on the wavelength of the exciting light, since the emission is generated by the lowest of the excited states. The fluorescence spectrum is often a "mirror image" of the absorption spectrum. By fixing the emission monochromator and scanning with the excitation monochromator, the fluorescence excitation spectrum can be obtained. The excitation spectrum is the dependence of the emission intensity at a given wavelength when scanning along the wavelengths of the exciting light. It is also possible to carry out simultaneous scanning with both monochromators and obtain spectra of synchronous scanning.

EXPERIMENTAL RESULTS AND THEIR DISCUSSION

A characteristic property of the fluorescence spectrum is high resolution, accompanied by processes associated with the chemical composition of the sample, structural elements, and other dynamic changes. The fluorescence spectrum has a fairly short time range, since fluorescence begins 10–8 sec after light absorption. During this period of time, all processes take place at the molecular level, nonradiative energy transfers, as well as the exchange of charges and energies between the components, are reflected in the fluorescence spectra, in the results of short-term dynamic processes, in the study of static properties and properties, as well as processes that are detected using a light signal detected by narrow luminescence bands.

The results of studying the excitation spectra of fish scales are shown in Fig.1.

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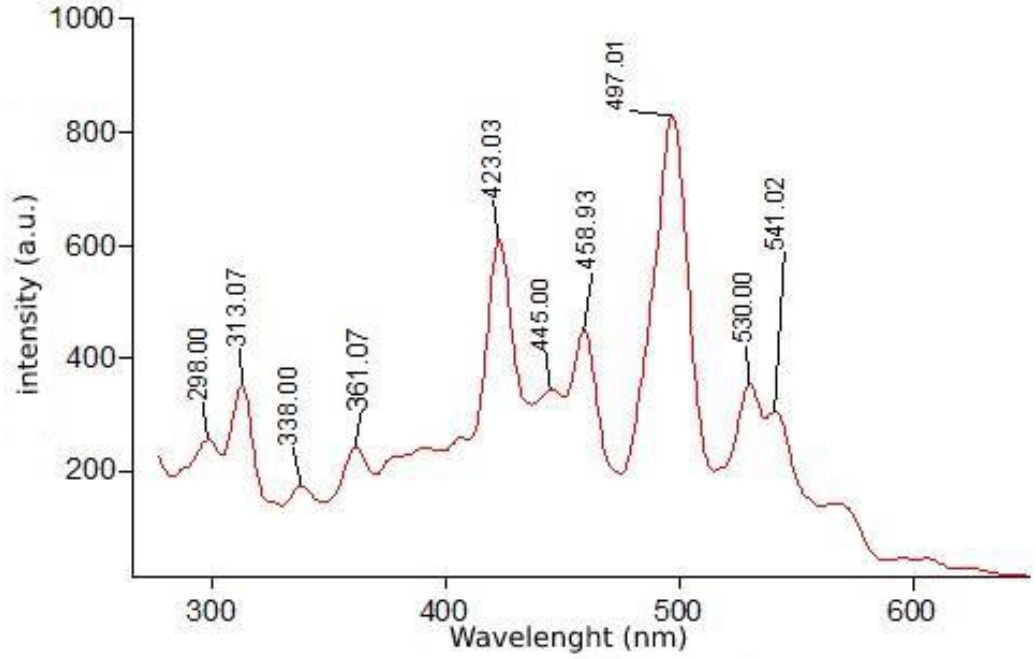


Fig.1. General excitation spectrum of fish scales.

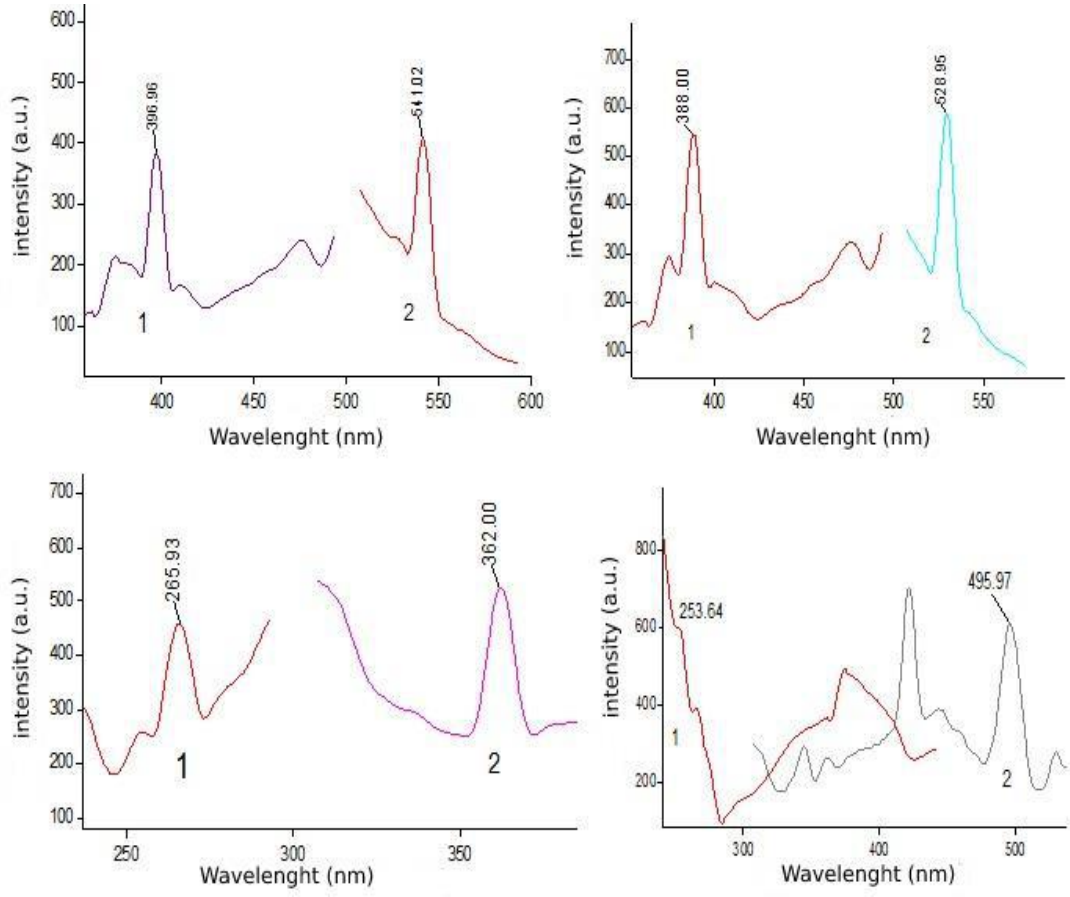
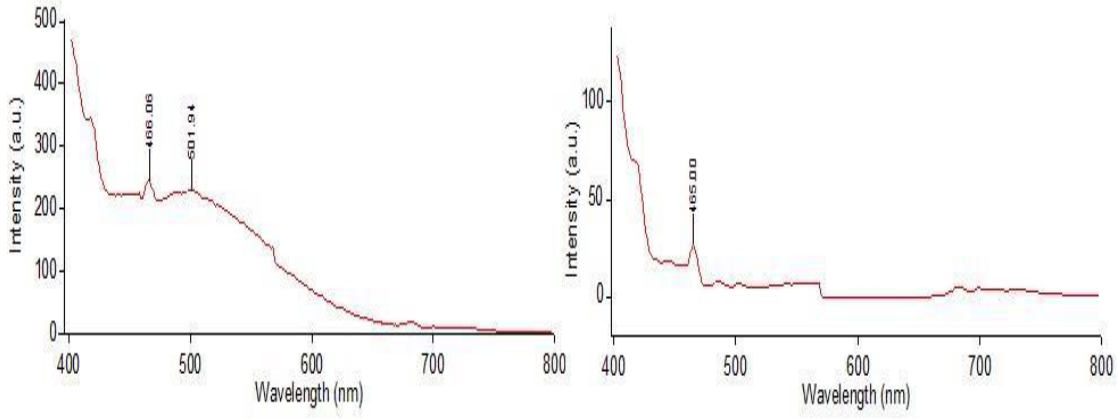


Fig.2. Spectrum of fluorescence at different points of the fish.



a) b)

Fig.3. Luminescence spectra of LDPE biocomposite +7 vol.% FS (a) and LDPE bionanocomposite +7 vol.% FS +3 vol.% Fe (b).

The resulting spectrum reflects the characteristic radiation, which is obtained by excitation of fish scales with light at a wavelength of 230 nm. The spectrum includes different peaks that correspond to the fluorescence of fish scales and is attached to Fig.2. As can be seen from Fig.2, with an excitation signal with a wavelength of 396.96; 388; 265.93; 253,64 fluorescence effects are observed. Note that at wavelengths of 541.02; 528.96; 362.00 and 495.97 the intensities of the peaks we detected increase in almost all excitations. Thus, upon excitation at a wavelength of 396.96 nm, the intensity of the fluorescence peaks increases by 28 a.u., and upon excitation at a wavelength of 380 nm, the intensity of the fluorescence peaks increases by 40 a.u. Correspondingly, at a wavelength of 265.95 nm, the intensity of the fluorescence peaks increases by 63 a.u., and upon excitation at a wavelength of 253.64 nm, the intensity of the fluorescence peaks increases by 13 a.u.

Thus, the fluorescence spectra of Kutum fish scales were studied in the wavelength range of 200-600 nm, and it was found that these materials can be widely used in multifunctional electronic devices and used as new-type composites with unique properties. Note that the effects observed in the fluorescence spectrum of Kutum fish scales can be controlled by the choice of scales from different parts of the fish skin.

The luminescence spectra were studied in composites of LDPE + x vol.% FS. Luminescence effects were also found in composites of LDPE + 7 vol.% FS and LDPE + 7 vol.% FS + 3 vol.% Fe (Fig.3). It was found that in the HPPE + 7 vol.% FS composite, upon excitation at a wavelength of 466.06 nm, the intensity of the luminescence peak is 32 atomic energy units, and upon excitation at a wavelength of 501.94 nm, the luminescence intensity is 9.2 atomic energy units.

In the LDPE bionanocomposite +7 vol.% FS + 3 vol.% Fe, upon excitation at a wavelength of 465 nm, a single relatively pronounced luminescence peak with an intensity of 20 atomic energy units is observed.

Comparing the intensities of the obtained luminescence peaks with the intensities of the excitation signals, we can conclude that in some of the studied biocomposites, pronounced luminescence spectra are obtained. This allows us to conclude that the luminescent property, which is of practical importance, can be achieved by changing the composition of the studied biocomposites and bionanocomposites, as well as choosing the appropriate excitation.

CONCLUSIONS

Studies of the luminescent properties of bionanocomposites LDPE + x vol.% FS + y vol.% Fe revealed that these materials have luminescent properties, practical significance and controllable changes in the volume content of the biofiller and metal nanoparticles.

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