FULL-COLOR BIOMIMETIC PHOSPHOR COMPOSITION, FULL-COLOR BIOMIMETIC PHOSPHOR FILM, AND FULL-COLOR BIOMIMETIC LIGHT SOURCE

[0001] The present application claims the priority of the Chinese patent application filed with the Chinese Patent Office on November 21, 2022 with an application number 202211456611.8 and titled "FULL-COLOR BIOMIMETIC PHOSPHOR COMPOSITION, FULL-COLOR BIOMIMETIC PHOSPHOR FILM, AND FULL-COLOR BIOMIMETIC LIGHT SOURCE", the entire contents of which are incorporated by reference in the present application.

TECHNICAL FIELD

[0002] The present application relates to the technical field of optical lighting technology, more particularly to a full-color biomimetic phosphor composition, a full-color biomimetic phosphor film, and a full-color biomimetic light source.

BACKGROUND

[0003] With the development of society, people's production and life activities under artificial light sources are increasing, and the time is getting longer and longer. LED light source is one of the most commonly used white light sources in production and life, with the advantages of high brightness, low energy consumption, and high safety.

[0004] However, the white light LED light source of the prior art still has some shortcomings. First, natural light is recognized as ideal lighting light. The white light generated by the white light LED light source is quite different from natural light, which makes people feel uncomfortable. Second, the white light generated by the white light LED light source has a high blue light content, which is harmful to people, such as causing cataracts and affecting sleep. Third, the white light generated by the white light LED light source has a low color rendering index, which is not realistic and deviates from the object and environment.

SUMMARY

[0005] The purpose of the present application is to provide a full-color biomimetic phosphor composition, a full-color biomimetic phosphor film, and a full-color biomimetic light source to

solve the technical problems that the white light generated by the white light LED light source in the prior art is greatly different from natural light and has high blue light and low color rendering index.

[0006] In order to achieve the above application purpose, the first aspect of embodiments of the present application provides a full-color biomimetic phosphor composition. The full-color biomimetic phosphor composition of the embodiments of the present application comprises: a first phosphor, a second phosphor and a third phosphor. An emission wavelength of the first phosphor is 480 nm to 500 nm; an emission wavelength of the second phosphor is greater than 500 nm and smaller than 620 nm; and an emission wavelength of the third phosphor is greater than or equal to 620 nm. A mass ratio of the first phosphor, the second phosphor, and the third phosphor is (15 to 70) : (15 to 70) : (13 to 70).

[0007] In the full-color biomimetic phosphor composition of the embodiments of the present application, the first phosphor, the second phosphor, and the third phosphor with different emission wavelengths cooperate with one another, so that the white light generated by the full-color biomimetic phosphor composition comprises visible light of different bands in the range of 400 nm to 800 nm. Moreover, by adjusting the mass ratio of the first phosphor, the second phosphor, and the third phosphor, the absolute optical powers of the visible light of different bands in the white light are close to those in the natural light, and the absolute optical power of the blue light is reduced, thereby improving the similarity and color rendering index of the white light with the natural light, increasing the comfort of the white light when used, and improving the authenticity of the environment and objects.

[0008] In a second aspect of the embodiments of the present application, a full-color biomimetic phosphor film is provided. The full-color biomimetic phosphor film of the embodiments of the present application comprises a film-forming material and the full-color biomimetic phosphor composition according to the above embodiments of the present application dispersed in the film-forming material.

[0009] The full-color biomimetic phosphor film of the embodiments of the present application comprises the full-color biomimetic phosphor composition of the embodiments of the present application, so that the full-color biomimetic phosphor film of the embodiments of the present application is excited to generate a white light with high color rendering index and low blue light, which highly simulates the natural light.

What is claimed is:

1. A full-color biomimetic phosphor composition, wherein the full-color biomimetic phosphor composition comprises:

a first phosphor, wherein an emission wavelength of the first phosphor is 480 nm to 500 nm;

a second phosphor, wherein an emission wavelength of the second phosphor is greater than 500 nm and smaller than 620 nm;

a third phosphor, wherein an emission wavelength of the third phosphor is greater than or equal to 620 nm;

wherein

a mass ratio of the first phosphor, the second phosphor, and the third phosphor is (15 to 70) : (15 to 70) : (13 to 70);

a first phosphor comprises a phosphor A, and an emission wavelength of the phosphor A is 480 nm and/or 488 nm to 492 nm;

the second phosphor comprises a phosphor B, and an emission wavelength of the phosphor B is 523 nm to 542 nm; and

the third phosphor comprises: a phosphor C, a phosphor D, a phosphor E, and a phosphor F; an emission wavelength of the phosphor C is 628 nm to 681 nm, an emission wavelength of the phosphor D is 718 nm to 722 nm, an emission wavelength of the phosphor E is 738 nm to 742 nm, and an emission wavelength of the phosphor F is 793 nm to 797 nm.

2. The full-color biomimetic phosphor composition according to claim 1, wherein the first phosphor, the second phosphor, and the third phosphor are provided separately;

the phosphor B in the second phosphor comprises a phosphor B1 and a phosphor B2; an emission wavelength of the phosphor B1 is 523 nm to 527 nm; an emission wavelength of the phosphor B2 is 538 nm to 542 nm; and a mass ratio of the phosphor B1 to the phosphor B2 is (20 to 85) : (10 to 85); and

the phosphor C in the third phosphor comprises: a phosphor C1, a phosphor C2, and a phosphor C3; an emission wavelength of the phosphor C1 is 628 nm to 632 nm, an emission wavelength of the phosphor C2 is 658 nm to 662 nm, and an emission wavelength of the

phosphor C3 is 677 nm to 681 nm; and a mass ratio of the phosphor C1, the phosphor C2, the phosphor C3, the phosphor D, the phosphor E, and the phosphor F is (3 to 35) : (1 to 45) : (3 to 60) : (7 to 90) : (7 to 60) : (1 to 70).

3. The full-color biomimetic phosphor composition according to claim 1, wherein

the phosphor C in the third phosphor forms a first mixture with the first phosphor and the second phosphor;

the phosphor D, the phosphor E, and the phosphor F in the third phosphor form a second mixture;

in the first mixture, a mass ratio of the phosphor A, the phosphor B, and the phosphor C is (10 to 80) : (15 to 85) : (1 to 40);

in the second mixture, a mass ratio of the phosphor D, the phosphor E, and the phosphor F is (20 to 120) : (10 to 90) : (1 to 100); and

the first mixture and the second mixture are provided separately.

4. The full-color biomimetic phosphor composition according to claim 1, wherein particle sizes of the first phosphor, the second phosphor, and the third phosphor are independently smaller than or equal to 50 μm.

5. A full-color biomimetic phosphor film, wherein the full-color biomimetic phosphor film comprises a film-forming material and the full-color biomimetic phosphor composition according to claim 1 dispersed in the film-forming material.

6. The full-color biomimetic phosphor film according to claim 5, wherein

the first phosphor, the second phosphor, and the third phosphor are provided separately;

the phosphor B in the second phosphor comprises a phosphor B1 and a phosphor B2; an emission wavelength of the phosphor B1 is 523 nm to 527 nm; an emission wavelength of the phosphor B2 is 538 nm to 542 nm; and a mass ratio of the phosphor B1 to the phosphor B2 is (20 to 85) : (10 to 85);

the phosphor C in the third phosphor comprises: a phosphor C1, a phosphor C2, and a phosphor C3; an emission wavelength of the phosphor C1 is 628 nm to 632 nm, an emission wavelength of the phosphor C2 is 658 nm to 662 nm, and an emission wavelength of the phosphor C3 is 677 nm to 681 nm; and a mass ratio of the phosphor C1, the phosphor C2, the phosphor C3, the phosphor D, the phosphor E, and the phosphor F is (3 to 35) : (1 to 45) : (3 to 60) : (7 to 90) : (7 to 60) : (1 to 70);

the full-color biomimetic phosphor film comprises: a first film layer, a second film layer, and a third film layer, which are stacked, the first film layer comprises the first phosphor, the second film layer comprises the second phosphor, and the third film layer comprises the third phosphor.

7. The full-color biomimetic phosphor film according to claim 6, wherein

in the first film layer, the first phosphor accounts for 30% to 85% of a total mass of the film-forming material and the first phosphor; and/or

in the second film layer, the second phosphor accounts for 30% to 85% of a total mass of the film-forming material and the second phosphor; and/or

in the third film layer, the third phosphor accounts for 40% to 87% of a total mass of the film-forming material and the third phosphor; and/or

the full-color biomimetic phosphor film is prepared by a film pressing method, and a film thickness of any one of the first film layer, the second film layer, and the third film layer is 0.06 mm to 0.15 mm; or alternatively, the full-color biomimetic phosphor film is prepared by a spray coating method, and a film thickness of any one of the first film layer, the second film layer, and the third film layer is 0.001 mm to 0.01 mm.

8. The full-color biomimetic phosphor film according to claim 5, wherein

the phosphor C in the third phosphor forms a first mixture with the first phosphor and the second phosphor;

the phosphor D, the phosphor E, and the phosphor F in the third phosphor form a second mixture;

in the first mixture, a mass ratio of the phosphor A, the phosphor B, and the phosphor C

is (10 to 80) : (15 to 85) : (1 to 40);

in the second mixture, a mass ratio of the phosphor D, the phosphor E, and the phosphor F is (20 to 120) : (10 to 90) : (1 to 100);

the first mixture and the second mixture are provided separately;

the full-color biomimetic phosphor film comprises a fourth film layer and a fifth film layer which are stacked, the fourth film layer comprises the first mixture, the fifth film layer comprises the second mixture, wherein particle sizes of the first phosphor, the second phosphor, and the third phosphor are independently smaller than or equal to 50 μm.

9. The full-color biomimetic phosphor film according to claim 8, wherein

in the fourth film layer, the first mixture accounts for 40% to 85% of a total mass of the film-forming material and the first mixture; and/or

in the fifth film layer, the second mixture accounts for 15% to 85% of a total mass of the film-forming material and the second mixture; and/or

the full-color biomimetic phosphor film is prepared by a film pressing method and a film thickness of any one of the fourth film layer and the fifth film layer is 0.06 mm to 0.15 mm, or alternatively, the full-color biomimetic phosphor film is prepared by a spray coating method and a film thickness of any one of the fourth film layer and the fifth film layer is 0.001 mm to 0.01 mm.

10. A full-color biomimetic light source, comprising at least one light-emitting unit, the light-emitting unit comprising:

a chip, and

a full-color biomimetic phosphor film, comprising a film-forming material and the full-color biomimetic phosphor composition according to claim 1;

wherein the full-color biomimetic phosphor composition is dispersed in the film-forming material, and the full-color biomimetic phosphor film is arranged on an optical path of the chip.

11. The full-color biomimetic light source according to claim 10, wherein

the first phosphor, the second phosphor, and the third phosphor are provided separately;

the phosphor B in the second phosphor comprises a phosphor B1 and a phosphor B2; an emission wavelength of the phosphor B1 is 523 nm to 527 nm; an emission wavelength of the phosphor B2 is 538 nm to 542 nm; and a mass ratio of the phosphor B1 to the phosphor B2 is (20 to 85) : (10 to 85);

the phosphor C in the third phosphor comprises: a phosphor C1, a phosphor C2, and a phosphor C3; an emission wavelength of the phosphor C1 is 628 nm to 632 nm, an emission wavelength of the phosphor C2 is 658 nm to 662 nm, and an emission wavelength of the phosphor C3 is 677 nm to 681 nm; and a mass ratio of the phosphor C1, the phosphor C2, the phosphor C3, the phosphor D, the phosphor E, and the phosphor F is (3 to 35) : (1 to 45) : (3 to 60) : (7 to 90) : (7 to 60) : (1 to 70);

the full-color biomimetic phosphor film comprises: a first film layer, a second film layer, and a third film layer, which are stacked, the first film layer comprises the first phosphor, the second film layer comprises the second phosphor, and the third film layer comprises the third phosphor; and

the following conditions are satisfied:

a layer with a smallest light refractive index among the first film layer, the second film layer, and the third film layer is arranged close to the chip, or alternatively, a layer with a smallest light refractive index among the fourth film layer and the fifth film layer is arranged close to the chip; and

a light emission wavelength of the chip is 440 nm to 475 nm.

12. The full-color biomimetic light source according to claim 11, wherein the full-color biomimetic light source comprises the following three light-emitting units:

a first light-emitting unit, comprising: a first chip, and a first full-color biomimetic phosphor film arranged on an optical path of the first chip;

a second light-emitting unit, comprising: a second chip, and a second full-color biomimetic phosphor film arranged on an optical path of the second chip; and

a third light-emitting unit, comprising: a third chip, and a third full-color biomimetic phosphor film arranged on an optical path of the third chip.

13. The full-color biomimetic light source according to claim 12, wherein

emission wavelengths of the first chip, the second chip, and the third chip are independently 440 nm to 460 nm; and

the first full-color biomimetic phosphor film comprises: the first film layer, the second film layer, and the third film layer; the second full-color biomimetic phosphor film comprises: the first film layer, the second film layer, and the third film layer; the third full-color biomimetic phosphor film comprises: the first film layer, the second film layer, and the third film layer; a mass ratio of the first phosphor in the first film layer, the second phosphor in the second film layer, and the third phosphor in the third film layer is (25 to 60) : (25 to 55) : (13 to 60); in the first film layer, the first phosphor accounts for 40% to 75% of a total mass of the film-forming material and the first phosphor; in the second film layer, the second phosphor accounts for 45% to 75% of a total mass of the film-forming material and the second phosphor; and in the third film layer, the third phosphor accounts for 50% to 80% of a total mass of the film-forming material and the third phosphor.

14. The full-color biomimetic light source according to claim 12, wherein emission wavelengths of the first chip, the second chip, and the third chip are independently 440 nm to 460 nm; and

the first full-color biomimetic phosphor film comprises the fourth film layer and the fifth film layer,

the second full-color biomimetic phosphor film comprises the fourth film layer and the fifth film layer,

the third full-color biomimetic phosphor film comprises the fourth film layer and the fifth film layer,

a mass ratio of the first mixture in the fourth film layer to the second mixture in the fifth film layer is (15 to 60) : (20 to 80),

in the fourth film layer, the first mixture accounts for 40% to 80% of a total mass of the first mixture and the film-forming material, and

in the fifth film layer, the second mixture accounts for 20% to 80% of a total mass of the second mixture and the film-forming material.

15. The full-color biomimetic light source according to claim 10, wherein a white light generated by the full-color biomimetic light source has any of the following spectral characteristics:

an absolute spectral power value of a violet light in a band of 380 nm to 435 nm is smaller than 0.45;

an absolute spectral power value of a blue light in a band of 435 nm to 475 nm is greater than 0.40 and smaller than 0.80;

an absolute spectral power value of a cyan light in a band of 475 nm to 492 nm is greater than 0.30;

an absolute spectral power value of an orange light in a band of 597 nm to 622 nm is greater than 0.80; and

an absolute spectral power value of a red light in a band of 622 nm to 700 nm is greater than 0.70.

16. The full-color biomimetic light source according to claim 15, wherein

a color temperature of a white light is smaller than 4000K, an absolute spectral power value of a green light in a band of 492 nm to 577 nm is smaller than 0.70, and an absolute optical power value of a yellow light in a band of 577 nm to 597 nm is smaller than 0.80.

17. The full-color biomimetic light source according to claim 15, wherein

a color temperature of the white light is greater than or equal to 4000K, an absolute spectral power value of a green light in a band of 492 nm to 577 nm is greater than 0.65, and an absolute optical power value of a yellow light in a band of 577 nm to 597 nm is greater than 0.80.

18. The full-color biomimetic light source according to claim 11, wherein

in the first film layer, the first phosphor accounts for 30% to 85% of a total mass of the film-forming material and the first phosphor; and/or

in the second film layer, the second phosphor accounts for 30% to 85% of a total mass of

the film-forming material and the second phosphor; and/or

in the third film layer, the third phosphor accounts for 40% to 87% of a total mass of the film-forming material and the third phosphor; and/or

the full-color biomimetic phosphor film is prepared by a film pressing method, and a film thickness of any one of the first film layer, the second film layer, and the third film layer is 0.06 mm to 0.15 mm; or alternatively, the full-color biomimetic phosphor film is prepared by a spray coating method, and a film thickness of any one of the first film layer, the second film layer, and the third film layer is 0.001 mm to 0.01 mm.

19. The full-color biomimetic light source according to claim 10, wherein

the phosphor C in the third phosphor forms a first mixture with the first phosphor and the second phosphor;

the phosphor D, the phosphor E, and the phosphor F in the third phosphor form a second mixture;

in the first mixture, a mass ratio of the phosphor A, the phosphor B, and the phosphor C is (10 to 80) : (15 to 85) : (1 to 40);

in the second mixture, a mass ratio of the phosphor D, the phosphor E, and the phosphor F is (20 to 120) : (10 to 90) : (1 to 100);

the first mixture and the second mixture are provided separately;

the full-color biomimetic phosphor film comprises a fourth film layer and a fifth film layer which are stacked, the fourth film layer comprises the first mixture, the fifth film layer comprises the second mixture, wherein particle sizes of the first phosphor, the second phosphor, and the third phosphor are independently smaller than or equal to 50 μm;

the following conditions are satisfied:

a layer with a smallest light refractive index among the first film layer, the second film layer, and the third film layer is arranged close to the chip, or alternatively, a layer with a smallest light refractive index among the fourth film layer and the fifth film layer is arranged close to the chip; and

a light emission wavelength of the chip is 440 nm to 475 nm.

20. The full-color biomimetic light source according to claim 19, wherein

in the fourth film layer, the first mixture accounts for 40% to 85% of a total mass of the film-forming material and the first mixture; and

in the fifth film layer, the second mixture accounts for 15% to 85% of a total mass of the film-forming material and the second mixture; and

the full-color biomimetic phosphor film is prepared by a film pressing method and a film thickness of any one of the fourth film layer and the fifth film layer is 0.06 mm to 0.15 mm, or alternatively, the full-color biomimetic phosphor film is prepared by a spray coating method and a film thickness of any one of the fourth film layer and the fifth film layer is 0.001 mm to 0.01 mm.