

(19) State Intellectual Property Office of the People's Republic of China



(12) Patent Invention Application Publication Specification

[21] Application no. 200810065260.1

[51] INT.CL.
F21S 19/00 (2006.01)
F21K 2/00 (2006.01)
F21V7104(2006.01)
F21V9/00 (2006.01)
F21V 13/00 (2006.01)
F21V 101/02(2006.01)

(11)Publication No.CN
101498415 A

[43] Publication date: August 5, 2009

(22)Date of Application: 2008.1.30

(21)Application No.: 200810065260.1

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4 pages of Patent claims 9 pages of description

4 pages of attached diagrams

(54)Name of Invention:

Light source and method for enhancing mixed
light emission efficiency based on fluorescent powder

(57)Abstract

A light source and method for enhancing the emission efficiency of mixed light based on fluorescent powder comprise an excitation light source (1), and in particular, a dichroic filter (2), which can divide the excitation light into two paths through transmission and reflection, one of the paths is guided to the excitation material (3) and converted into excited light, which is then guided to the light emission source, and the other path is guided to the light emission surface to mix with the excited light; and the two paths of light are guided by the first and second reflective surfaces, resulting in a mixed light output with a predetermined ratio and higher efficiency. The first reflective surface (4) can utilize a heat-conducting medium that is closely attached to the excitation material (3). The excitation material (3) can include multiple types and is distributed in different regions of a turntable (5). The present invention enhances the efficiency of the light source and has the advantages of enabling easy color designs, a long lifespan, and low cost.

1. A light source for enhancing the emission efficiency of mixed light based on fluorescent powder comprises an excitation light source (1), an excitation material layer where the excitation material (3) is located, and a first reflective surface (4) adjacent to the excitation material layer, which guides the excited light of the excitation material (3) to the same side of the first reflective surface (4); its characteristics are:

It also includes a dichroic filter (2) and a second reflective surface (5), the excitation light source (1) faces the dichroic filter (2), so that the excitation light is obliquely incident on the dichroic filter (2), the excited material layer and the second reflective surface (5) are positioned on opposite sides of the dichroic filter (2), each substantially aligned to face the excitation light guided by the dichroic filter (2).

2. According to claim 1, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as follows:

The dichroic filter (2) is positioned between the excitation light source (1) and the excitation material layer. It guides a part of the excitation light from the excitation light source (1) to the excitation material (3), simultaneously guiding the excitation light from the excitation light source (1) to the second reflective surface (5) in a reflective manner.

The dichroic filter (2) also guides the excited light of the excitation material (3) to the light emission surface of the light source in a reflective manner and guides a part of the excitation light reflected from the second reflective surface (5) to the light emission surface of the light source in a transmissive manner.

3. According to claim 2, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized by:

The light emission surface of the excitation light source (1) is substantially parallel to the plane where the excitation material layer is located and is inclined at approximately 45 degrees to the plane where the dichroic filter (2) is located.

4. According to claim 1, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized by:

The light emission surface of the excitation light source (1) and the excitation material layer are positioned on the same side of the dichroic filter (2), and the planes where they are located intersect each other so that the dichroic filter (2) guides a part of the excitation light from the excitation light source (1) to the excitation material (3) in a reflective manner, and simultaneously guides another part of the excitation light from the excitation light source (1) to the second reflective surface (5) in a transmissive manner.

Furthermore, the dichroic filter (2) guides the excited light of the excitation material (3) to the light emission surface of the light source in a transmissive manner and guides a part of the excitation light reflected from the second reflective surface (5) to the light emission surface of the light source in a reflective manner.

5. According to claim 4, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as:

The light emission surface of the excitation light source (1) is substantially orthogonal to the plane where the excitation material layer is located, and the light emission surface of the excitation light source (1) and the excitation material layer are each at an angle of substantially 45 degrees to the plane where the dichroic filter (2) is located.

6. According to claim 1, the light source for enhancing the mixed light emission efficiency based on fluorescent is characterized as:

Additionally, it includes a second excitation material layer, which is located between the dichroic filter (2) and the second reflective surface (5), in close proximity to or closely attached to the second reflective surface (5).

7. According to claims 1 & 6, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as:

The first reflective surface (4) or the second reflective surface (5) is composed of a heat-conducting medium and closely attached to the corresponding excitation material layer of the first reflective surface (4) or the second reflective surface (5).

8. According to claim 7, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as:

The first reflective surface (4) or the second reflective surface (5) connects to a heat sink or is a surface of the heat sink.

9. According to claim 8, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as:

The heat sink is a heat conductive shell of the light source module; the first reflective surface (4) or the second reflective surface (5) is an inner wall of the shell, or is a mirror fixed on the shell or on the inner wall of the shell.

10. According to any of claims 1 through 5, a light source to enhance the mixed light emission efficiency based on fluorescent powder is characterized as:

It also includes a transparent light-guiding medium (6) positioned on one side or both sides of the dichroic filter (2).

11. According to claim 10, light source to enhance the mixed light emission efficiency based on fluorescent powder is characterized as:

The transparent light-guiding medium (6) is a triangular prism glass column, with one surface closely attached to the dichroic filter (2).

12. According to claim 1, the light source for enhancing the mixed light emission efficiency based on fluorescent powder is characterized as:

It also includes a turntable carrying the excitation material layer, with the rotating axis (7) of the turntable as the center, at least two kinds of fluorescent powders (3, 3') are distributed in the excitation material layer along the circumference; the first reflective surface (4) is fixed on the turntable, or is the face of the turntable.

13. A method for enhancing the emission efficiency of mixed light based on fluorescent powder, to be used in a light source, includes the following steps:

A. Generating excitation light by an excitation light source (1) included in the light source;

B. The light source includes an excitation material layer where the excitation material (3) is located, and the excitation material (3) is excited by the excitation light to emit light; guiding the excited light to the light emission surface of the light source;

C. Guiding a part of the excitation light to the light emission surface of the light source;

D. Emitting mixed light by the light source;

It is characterized as:

In step A, it also includes selecting and setting a dichroic filter (2) so that the excitation light is obliquely guided onto the dichroic filter (2) and is divided into two paths through transmission and reflection, one path is guided to the excitation material (3) for use in step B; the other path is for use in step C;

Step C also includes setting a second reflective surface (5) to reflect the excitation light guided from the dichroic filter (2) back to the dichroic filter (2), so that the excitation light is further divided into two paths. One path guides toward the excitation light source (1), and the other path guides to the light emission surface of the light source.

Step B also includes setting a first reflective surface (4) to guide the excited light to the same side and to guide it to the dichroic filter (2) and then to the light emission surface of the light source.

14. The method for enhancing the mixed light emission efficiency based on fluorescent powder according to claim 13, characterized by:

In step A, the excitation light is guided by the dichroic filter (2) towards the excitation material (3) in a transmissive manner; subsequently, the excited light in step B is guided by the dichroic filter (2) to the light emission surface of the light source in a reflective manner.

15. The method for enhancing the mixed light emission efficiency based on fluorescent powder according to claim 13, characterized by:

In step A, the excitation light is guided by the dichroic filter (2) towards the excitation material (3) in a reflective manner; subsequently, the excited light in step B is guided by the dichroic filter (2) towards the light emission surface of the light source in a transmissive manner.

16. According to claim 13, the method for enhancing the mixed light emission efficiency based on fluorescent powder is characterized by:

Step C also includes setting a second excitation material layer between the dichroic filter (2) and the second reflective surface (5) in close proximity to or closely attached to the second reflective surface (5), which is used to accommodate a second excitation material (3'), in order to convert the excitation light guided from the dichroic filter (2) into a second excited light and guide it towards the dichroic filter (2), replacing the excitation light and being guided to the light emission surface of the light source.

17. According to claim 13 or 16, the method for enhancing the mixed light emission efficiency based on fluorescent powder is characterized by:

The first reflective surface (4) or the second reflective surface (5) is composed of a heat-conducting medium and is positioned to be closely attached to the excitation material layer corresponding to the first reflective surface (4) or the second reflective surface (5).

18. According to claim 13, the method for enhancing the mixed light emission efficiency based on fluorescent powder is characterized by:

The excitation material (3) includes at least two types, which are positioned to be distributed in different areas along the circumference of a turntable with a rotating axis (7) as the center.

Light source and method for enhancing mixed light emission efficiency based on fluorescent powder

Technical domain: The present invention relates to a light source module, and in particular, to a light source module utilizing fluorescent powder excitation, and specifically to a light source structure and method for enhancing the efficiency of mixed light more efficiently by means of assembly of components.

Background technology: Since the early 1990s, with the rapid advancement of a new generation of semiconductor optoelectronic materials like InGaAlP and InGaN, various high-power and high-brightness LED light sources in red, yellow, blue, green, ultraviolet, and white have emerged. One after another, they have been more and more widely used in display and lighting fields.

In addition to using corresponding color light-emitting diodes, the primary technical solutions that can be used to obtain various color light sources (especially white light sources) include RGB mixing and fluorescence conversion. Among them, the fluorescence conversion solution is to use the emission light from alternative light sources (such as, but not limited to, LED chips) to excite fluorescent powder, resulting in light with a longer wavelength. For example, the white light LED patent of Nichia Corporation of Japan discloses a technical solution using a 470 nanometer blue light LED chip to excite yellow YAG fluorescent powder for white light emission. This scheme has a simple structure, low manufacturing cost, and the product has strong practicality.

The Chinese patent application with application number 2005100720291 reveals a method for achieving white light through fluorescence conversion, in which fluorescent powder is coated on a reflector to separate it from the light-emitting diode, and the reflector is used to make the light emitted by the fluorescent powder be reflected and emitted from a predetermined emission surface. In this scheme, the light emitted by the light source is actually a mixture of the excited light and part of the diffused excitation light that is not absorbed and utilized by the fluorescent powder. By using the light source structure disclosed in this scheme, only the composition or distribution ratio of the fluorescent powder is changed, and the color or chromaticity of the light emitted by the light source can be designed. The disadvantage is that since part of the excitation light that is not absorbed and utilized by the fluorescent powder may be diffused toward the excitation light source, and at the same time, a considerable part of the excited light is diffused toward the excitation light source, these lights are difficult to be fully utilized, which reduces the efficiency of the mixed light emission of the light source. At the same time, the proportion of the excitation light diffused toward the light emission surface is

generally very small, which has a small impact on the chromaticity of the mixed light and is not conducive to the adjustment design of the light source color or chromaticity.

Invention Summary The invention aims to resolve the issues of the current technology and propose a light source structure and method that utilize a simple component assembly to enhance mixed light emission efficiency, which will enable the design of a light source to emit color or chromaticity.

In order to resolve the technical challenges mentioned earlier, the fundamental concept of the invention is to utilize the selection of a dichroic filter that can transmit and reflect excitation light, dividing the excitation light into two paths; one path will be directed to the excitation material, the other will be directed to the light emission surface; with the help of the necessary reflective surface to guide the paths of excitation light, one of the paths is converted to excited light through the excitation material, therefore, obtaining mixed light with the anticipated ratio and a better emission efficiency at the light source emission surface.

In order to realize the invention's concept, one technical solutions is to provide a method to boost mixed light emission efficiency using fluorescent powder to be used on a light source, including the following steps:

- A. Generating excitation light from an excitation light source within the light source.
- B. The light source includes an excitation material layer housing the excitation material. The located, and the excitation material is stimulated by the excitation light to emit light; guiding the excited light to the light emission surface of the light source;
- C. Guiding a part of the excitation light to the light emission surface of the light source;
- D. Emitting mixed light by the light source;

In particular, in step A, it also includes selecting and positioning a dichroic filter to guide the excitation light obliquely onto the dichroic filter and is divided into two paths through transmission and reflection. One path leads to the excitation material for use in step B; the other path is designated for step C;

Step C also includes setting a second reflective surface to reflect the excitation light guided from the dichroic filter back to the dichroic filter, so that the excitation light is further divided into two paths; one path guides toward the excitation light source, and the other path guides to the light emission surface of the light source;

Step B also includes setting a first reflective surface to guide the excited light to the same side, guiding it to the dichroic filter and then to the light emission surface of the light source.

In the aforementioned method, in Step A, the excitation light is guided by the dichroic filter towards the excitation material in a transmissive manner; subsequently, the excited light in step B is guided by the dichroic filter to the light emission surface of the light source in a reflective manner.

In the aforementioned method, in Step A, the excitation light is guided by the dichroic filter toward the excitation material in a reflective manner; subsequently, the excited light in Step B is guided by the dichroic filter towards the light emission surface of the light source in a transmissive manner.

In the aforementioned method, Step C also includes setting a second excitation material layer between the dichroic filter and the second reflective surface in close proximity to or closely attached to the second reflective surface, which is used to accommodate a second excitation material, in order to convert the excitation light guided from the dichroic filter into a second excited light and guide it towards the dichroic filter, replacing the excitation light and be guided to the light emission surface of the light source.

As a second technical solution to realize the concept of the present invention, a light source for enhancing the emission efficiency of mixed light based on fluorescent powder is provided, including an excitation light source, an excitation material layer where the excitation material is located, and a first reflective surface adjacent to the excitation material layer, which guides the excited light reflected from the excitation material to the same side of the first reflective surface; and in particular, it also includes a dichroic filter and a second reflective surface. The excitation light source faces the dichroic filter, allowing the excitation light to be obliquely incident on the dichroic filter. The excitation material layer and the second reflective surface are positioned on opposite sides of the dichroic filter, each substantially aligned to face the excitation light guided by the dichroic filter.

In the aforementioned solution, the dichroic filter is positioned between the excitation light source and the excitation material layer. It guides a part of the excitation light from the excitation light source to the excitation material in a transmissive manner and guides another part of the excitation light from the excitation light source to the second reflective surface in a reflective manner. The dichroic filter also guides the excited light of the excitation material to the light emission surface of the light source in a reflective manner and guides a part of the excitation light

reflected from the second reflective surface to the light emission surface of the light source in a transmissive manner.

In the aforementioned solution, the light emission surface of the excitation light source and the excitation material layer are positioned on the same side of the dichroic filter, and the planes where they are located intersect each other so that the dichroic filter guides a part of the excitation light from the excitation light source to the excitation material in a reflective manner, and simultaneously guides another part of the excitation light from the excitation light source to the second reflective surface in a transmissive manner; the dichroic filter also guides the excited light from the excitation material to the light emission surface of the light source in a transmissive manner and guides a part of the excitation light reflected from the second reflective surface to the light emission surface of the light source in a reflective manner.

In the aforementioned solution, the light source also includes a second excitation material layer, which is located between the dichroic filter and the second reflective surface and in close proximity to or closely attached to the second reflective surface.

In the aforementioned solution, either the first reflective surface or the second reflective surface consists of a heat-conducting medium, which is closely attached to the corresponding excitation material layer for the first reflective surface or the second reflective surface.

In the aforementioned method, the light source also includes a transparent light-guiding medium, which is positioned on one side or both sides of the dichroic filter.

In the aforementioned solution, it also includes a turntable carrying the excitation material layer, with the rotating axis of the turntable as the center, at least two kinds of fluorescent powders are distributed in the excitation material layer in different areas along the circumference; the first reflective surface is fixed on the turntable, or is the face of the turntable.

The aforementioned technical solutions enhance the emission efficiency of mixed light, and while the light source can emit higher brightness and power, it can also have the advantages of easy color design, long service lifespan, and low cost.

Description of the drawings:

Figure 1 is a schematic diagram of the structural principle of one of the light source embodiments of the present invention.

Figure 2 is a schematic diagram of the structural principle of a special example of the embodiment of Figure 1;

Figure 3 is an example diagram of the spectrum of white light achieved by the embodiment of Figure 1 or Figure 2,

Wherein curve a1 represents the spectrum of the dichroic filter, curve a2 represents the spectrum of the excitation light, and curve a3 represents the spectrum of the excited light.

Figure 4 is a schematic diagram of the structural principle of the second embodiment of the light source of the present invention.

Figure 5 is a specific example of the embodiment in Figure 4 and its enhanced structural principle diagram.

Figure 6 is an example diagram of the spectrum of blue-green light achieved by the embodiment in Figure 4 or Figure 5,

Wherein curve d1 represents the spectrum of the dichroic filter, curve d2 represents the spectrum of the excitation light, and curve d3 represents the spectrum of the excited light;

Figure 7 is a schematic diagram of the principle of an enhanced structure of the light source of the present invention, taking Figure 5 as an example.

Figure 8 is a spectrum diagram of a light source embodiment of another enhanced structure of the present invention to obtain white light.

Wherein curve b1 represents the spectrum of the dichroic filter, curve b2 represents the spectrum of the excitation light, and curves b3 and b4 represent the spectrum of the first and second excited lights, respectively.

The numeral labels in the above figures are: 1 - excitation light source; 2 - dichroic filter; 3, 3' - excitation material/excitation material layer; 4 - first reflection surface; 5 - second reflection surface; 6 - transparent light-guiding medium; 7 - rotating axis.

Specific implementation method: The present invention is further described below in conjunction with the best embodiment shown in the accompanying drawings.

Based on the steps included in the existing light source: the excitation light source 1 of the light source generates excitation light, which is emitted to the excitation material layer to excite the excitation

material 3 to emit light, and the excited light is guided to the light emission surface of the light source; the part of the excitation light that is not absorbed and utilized by the excitation material 3 is guided to the light emission surface of the light source and mixed with the excited light for output; the key to the method of the present invention is: selecting and setting a dichroic filter 2, and the excitation light obliquely incident on the dichroic filter 2 is divided into two paths through a transmission method and a reflection method, one path is guided to the excitation material layer, and the other path is not provided to the excitation material 3 for utilization but is guided to the light emission surface of the light source, which can greatly increase the mixing ratio of the excitation light in the light emitted by the light source, thereby facilitating the adjustment of the color of the output light source. In order to adapt to the aforementioned distribution scheme of the excitation light and make the light source structure as simple and compact as possible, the method of the present invention also includes the steps of: setting a second reflection surface 5 to reflect the excitation light guided from the dichroic filter 2 that is not provided to the excitation material 3 back to the dichroic filter 2, so that this part of the excitation light is also divided into two paths, one path is guided to the excitation light source 1, and the other path is guided to the light emission surface of the light source and being utilized; setting a first reflection surface 4 to reflect the excited light so as to guide the excited light from the excitation material 3 to the same side of the first reflection surface 4, directing it to the dichroic filter 2 and subsequently to the light emission surface of the light source.

According to the method, the light source of the present invention includes at least an excitation light source 1, an excitation material layer where the excitation material 3 is located, and a first reflection surface 4 adjacent to the excitation material layer, so that the excited light of the excitation material 3 is all guided to the same side of the first reflection surface 4 through reflection. It also includes a dichroic filter 2 and a second reflection surface 5, the excitation light source 3 faces the dichroic filter 2, allowing the excitation light to be obliquely incident on the dichroic filter 2; the excitation material layer and the second reflection surface 5 are positioned on opposite sides of the dichroic filter 2, respectively, and are roughly facing the excitation light guided by the dichroic filter 2. In this invention, the excitation light source can be a point light source or a surface light source. When the excitation light source is a point light source, for the convenience of description, unless otherwise specified, the primary optical axis light of the excitation light from the point light source is replaced by the excitation light in this description, and "facing" indicates that the plane and the primary optical axis of the light incident on the plane are perpendicular.

In the method of the present invention, according to the different allocation and use of the two paths of excitation light, the dichroic filter 2 should be selected to have corresponding different optical properties for the excitation light. For example, when the excitation light being guided to the excitation material 3

is selected to be the path that is transmitted through the dichroic filter 2, the excited light should be guided to the light emission surface of the light source by the dichroic filter 2 in a reflective manner. Therefore, the selected dichroic filter must simultaneously have a reflective effect on the excited light at the same time. Conversely, when the excitation light guided to the excitation material 3 is selected to be the path that is reflected by the dichroic filter 2, the excited light should be guided to the light emission surface of the light source by the dichroic filter 2 in a transmissive manner. Therefore, the selected dichroic filter must simultaneously have a transmissive effect on the excitation light at the same time.

This is further explained below by the light source structure of the illustrated embodiment.

One structural embodiment of the light source of the present invention is shown in Figure 1. The dichroic filter 2 is positioned between the excitation light source 1 and the excitation material/excitation material layer 3, receives the oblique radiation of the excitation light from the excitation light source 1, and guides part of the excitation light to the excitation material/excitation material layer 3 in a transmissive manner, while also guiding the other part of the excitation light to the second reflection surface 5 in a reflective manner. Therefore, the dichroic filter also guides the excited light of the excitation material 3 to the light emission surface of the light source in a reflective manner and guides part of the excitation light reflected from the second reflection surface 5 to the light emission surface of the light source in a transmissive manner.

Figure 2 is a special case of the light source structure of Figure 1. In this special case, the light emission surface of the excitation light source 1 is approximately parallel to the plane where the excitation material layer 3 is located and is approximately inclined at a 45-degree angle to the plane where the dichroic filter 2 is located, making it approximately orthogonal to the second reflection surface 5. The angle setting of this structure will maximize the use of light and make the light source structure more compact. However, the embodiment of Figure 1 is convenient for flexibly setting the light source according to the actual size requirements, and it also has its merits.

The embodiment of Figure 3 illustrates the selection of the characteristics of the dichroic filter 2 in the light source structure of Figures 1 and 2. Curve a2 represents the spectrum of the excitation light, which is a blue light; curve a3 represents the spectrum of the excited light, for example, yellow light is selected, using (but not limited to) 00901 of Taiwan Hongda Company, then the spectrum of the

dichroic filter 2 can be designed as shown in curve a1 to allow incident light with a shorter wavelength to pass through, and the turning point of its wavelength transmission characteristic is in the blue light region, so that a part of the blue light can be transmitted while reflecting another part of the blue light. By changing the position of the turning point of the wavelength transmission characteristic of curve a1, the ratio of transmitted and reflected blue light can be adjusted, thereby changing the mixing ratio of blue light and yellow light at the light emission surface end, and then white light of different color temperatures can be designed.

The second structural embodiment of the light source of the present invention is shown in Figure 4: the light emission surface of the excitation light source 1 and the excitation material 3 are positioned on the same side of the dichroic filter 2, and the planes where they are located intersect each other, so that the dichroic filter 2 guides a portion of the excitation light from the excitation light source 1 to the excitation material 3 in a reflective manner, and guides another part of the excitation light from the excitation light source 1 to the second reflective surface 5 in a transmissive manner; the dichroic filter 2 also guides the excited light of the excitation material 3 to the light emission surface of the light source in a transmissive manner, and guides a portion of the excitation light reflected from the second reflective surface 5 to the light emission surface of the light source in a reflective manner.

Figure 5 is a special example of the light source structure of Figure 4. The light emission surface of the excitation light source 1 and the plane where the excitation material 3 is located are approximately orthogonal; and are approximately 45 degrees with the plane where the dichroic filter 2 is located, so that the light emission surface of the excitation light source 1 and the second reflecting surface 5 are substantially parallel.

The embodiment of Figure 6 illustrates the selection of the characteristics of the dichroic filter 2 in the light source structure of Figure 4 and 5. The curve d2 represents the blue light spectrum of the excitation light, and the curve d3 represents the green light spectrum of the excited light. The spectrum of the dichroic filter 2 can be represented by curve d1, designed to pass incident light with a longer wavelength in order to transmit green light and a part of blue light while reflecting another part of blue light. Similarly, by changing the position of the turning point of the wavelength transmission characteristic of curve d1, the color or chromaticity of the emitted mixed light can be affected by adjusting the ratio of blue light transmission and reflection. Assuming that the transmittance ratio of the

dichroic filter 2 to the blue light in this embodiment is 20% as shown in the figure, the other 80% of the blue light will be reflected to the fluorescent powder to excite yellow light; and when the 20% of the blue light that transmits through the dichroic filter 2 is reflected back to the dichroic filter 2 by the second reflection surface 5, $20\% \times 80\% = 16\%$ of the blue light will enter the light emission surface of the light source in a reflective manner, and $20\% \times 20\% = 4\%$ of the blue light that transmits back to the excitation light source 1 can be regarded as the excitation light loss of the light source system. It can be seen that the loss can be very low, so that the light source of the present invention can provide a higher mixed light emission efficiency than the prior art. In other words, under the premise of not being lower than the existing mixed light emission efficiency, the light source of the present invention can conveniently change the color of the exit light very easily and over a wide range by simply replacing the dichroic filter 2.

In the light source of the present invention, when the light emitted power is relatively large, the first reflective surface 4 can be formed of a heat-conducting medium, and it can be closely attached to the excitation material/excitation material layer 3 to timely diffuse the heat generated by the fluorescent powder and avoid accumulation. This can enhance the light conversion efficiency of the excitation material and help extend the service lifespan of the excitation material. The thermal conductivity of the heat-conducting medium at room temperature is preferably greater than $10\text{W}/(\text{m}\cdot\text{K})$ (watt/meter*degree Kelvin), and metal (for example, but not limited to aluminum) or heat-conducting ceramics can be used. The first reflective surface 4 can also be connected to a heat sink or be a surface of the heat sink. According to the power design of the light source system, auxiliary heat dissipation means such as exhaust fans can be added when necessary, which are prior art and will not be described in detail.

In order to further reduce the loss of light, the method of the present invention can also, in the aforementioned embodiments, add a transparent light-conducting medium on one side or both sides of the dichroic filter to direct the excitation light or excited light. Taking the transparent light-guiding medium 6 shown by the dotted lines in Figure 2 and Figure 4 as an example, a glass prism (not limited to a triangular prism) can be used. One side of the prism is to be positioned close to the dichroic filter 2, and the other side is to be positioned close to the light emission surface of the excitation light source 1 or the excitation material 3, or the second reflector 5, so that the prism can play the role of an optical waveguide in the transmission process of the light.

Figure 7 illustrates an enhanced method that can be implemented in the light source structure of the present invention. The enhancement is made by taking Figure 5 as an example (also applicable to Figure 4), specifically, as shown by the dotted line, a turntable is used to carry two or more excitation materials 3 and 3'. In particular, these excitation materials can be arranged in the excitation material layer in various regions along the circumference of a turntable with a rotating axis 7 as the center. The first reflecting surface 4 can be the disk surface of the turntable, or the surface of a heat sink fixed on the turntable. In this way, on one hand, in the light source system with an exhaust fan, the rotational movement of the turntable can enhance the heat diffusion of the excitation material; another crucial aspect is that, considering the fluorescent powder in the prior art has an extremely short excited response time, it can be inferred that, as the turntable rotates, when the excitation light excites different excitation materials, excited lights of various colors can be achieved. By selecting a suitable dichroic filter 2 that can simultaneously reflect or transmit the two types of excited light, the colors of the excited light emitted to the same position of the dichroic filter 2 alternate continuously at different times. This enables uniform color mixing among the emitted excited lights, which then mixes with part of the excitation light guided to the light emission surface. An embodiment of using this enhanced structure to obtain a white light source can be: the excitation light is set to be blue light; the first excitation material 3 and the second excitation material 3' distributed in different regions are respectively green fluorescent powder and red fluorescent powder, which excite green light and red light respectively; a dichroic filter 2 is selected to have a certain transmittance for the blue light and a transmission effect for the green light and red light so that the emitted light of the light source is a mixed white light of a predetermined amount of blue light and the green light and red light transmitted through the dichroic filter 2. In this embodiment, a third excitation material, such as yellow fluorescent powder, can also be added to obtain a mixed white light composed of red, blue, green, and yellow.

The enhanced structure can also be implemented based on Figure 1 and 2, only the characteristics of the dichroic filter 2 for the two or more excited lights need to be changed accordingly, which will not be described in detail here.

When the light source of the present invention includes at least two types of excitation materials, in addition to uniformly mixing and distributing the two excitation materials in the excitation material layer, or distributing them in different regions according to the embodiments of the enhanced structure, the light source can also be enhanced as follows: based on the light source structure shown in Figure 1, 2, 4 or 5, a second excitation material layer is provided between the dichroic filter 2 and the second reflective surface 5, and in close proximity to or closely attached to the second reflective surface 5, to accommodate a second excitation material; the second excitation material is used to convert the excitation light in this path into a second excited light, which is guided to the light emission surface through the selected appropriate dichroic filter 2, and at least mixed with the first excitation light. Figure 8 illustrates the structure based on the figures shown in Figures 4 or 5 as an example to demonstrate the relevant spectrum of an embodiment for obtaining a white light source. Curve b2 depicts the spectrum of the excitation light, such as ultraviolet light; curve b3 represents the spectrum of the light emitted by the first excitation material 3 (such as yellow fluorescent powder), which appears yellow; curve b4 showcases the spectrum of the light emitted by the second excitation material (such as blue fluorescent powder), which appears blue; curve b1 showcases the dichroic characteristics of dichroic filter 2, which is selected to have a specific transmittance for ultraviolet light, reflect blue light, and transmit yellow light. Consequently, the light emitted by the light source is a blend of white light composed of the blue light reflected by dichroic filter 2 and the yellow light transmitted through dichroic filter 2. At this time, due to the absorption of the excitation light by the second excitation material, the amount of ultraviolet light in the light source that can return to the excitation light source 1 is minimal, and there is almost no light loss in the system.

Similarly, by changing the characteristics of the dichroic filter 2 for the two types of excited light, the enhancement can also be applicable to the structures shown in Figures 1 and 2, and will not be repeated here. In this improved structure, a heat-conducting medium can also be utilized to create the second reflection surface, and the second excitation material layer can be closely attached to the second reflection surface 5. The second reflection surface 5 can also be linked to a heat sink or serve as a surface of the heat sink.

In the light source module having the structure of the present invention, the heat sink may also be a heat-conducting shell of the light source module, and the first reflection surface 4 or the second

reflection surface 5 is the inner wall of the shell or is a mirror fixed on the shell or positioned based on the inner wall of the shell.

Excitation
Light Source

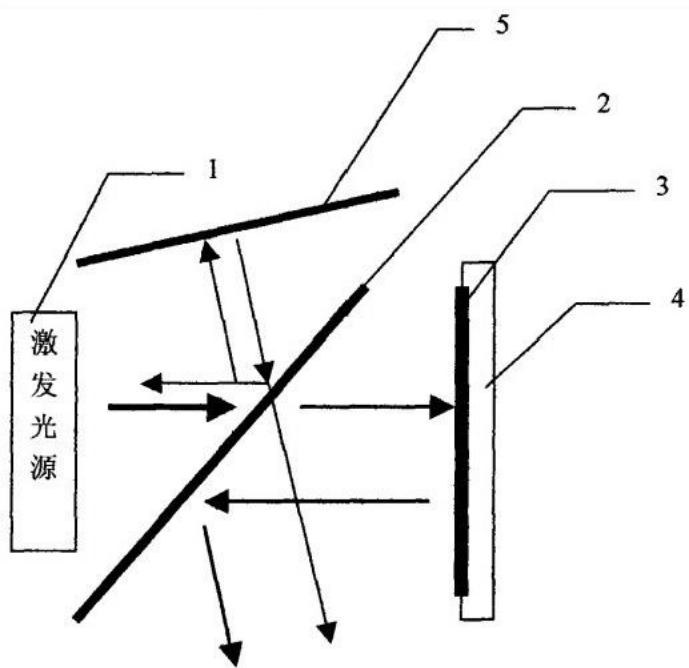


图 1

Figure 1

Excitation Light
Source

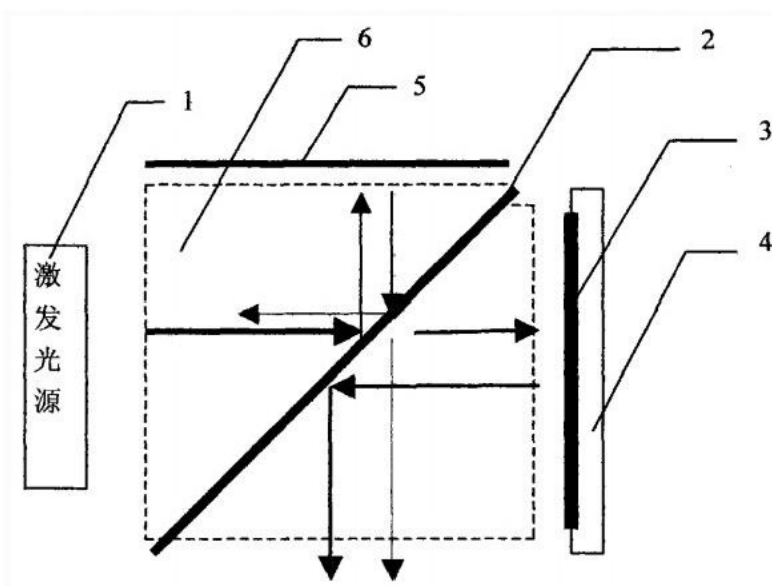
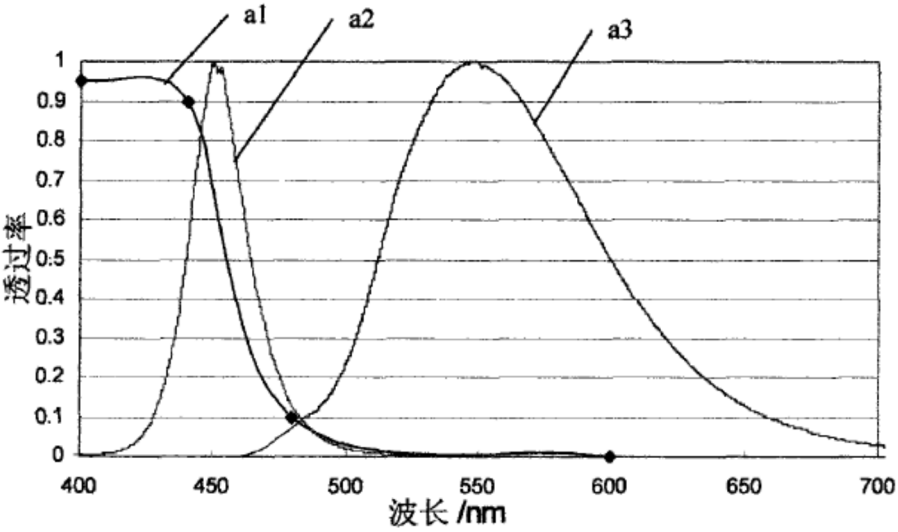


图 2

Figure 2

Transmittance



Wavelength

图 3

Figure 3

Excitation Light Source

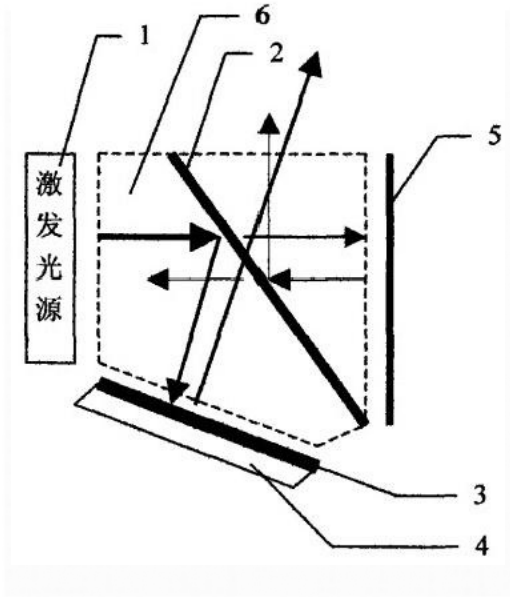


图 4

Figure 4

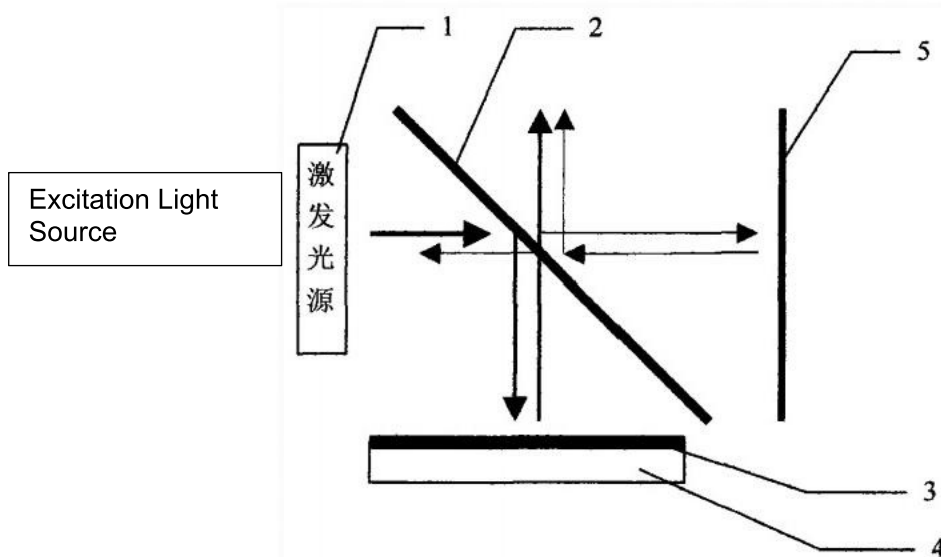


图 5

Figure 5

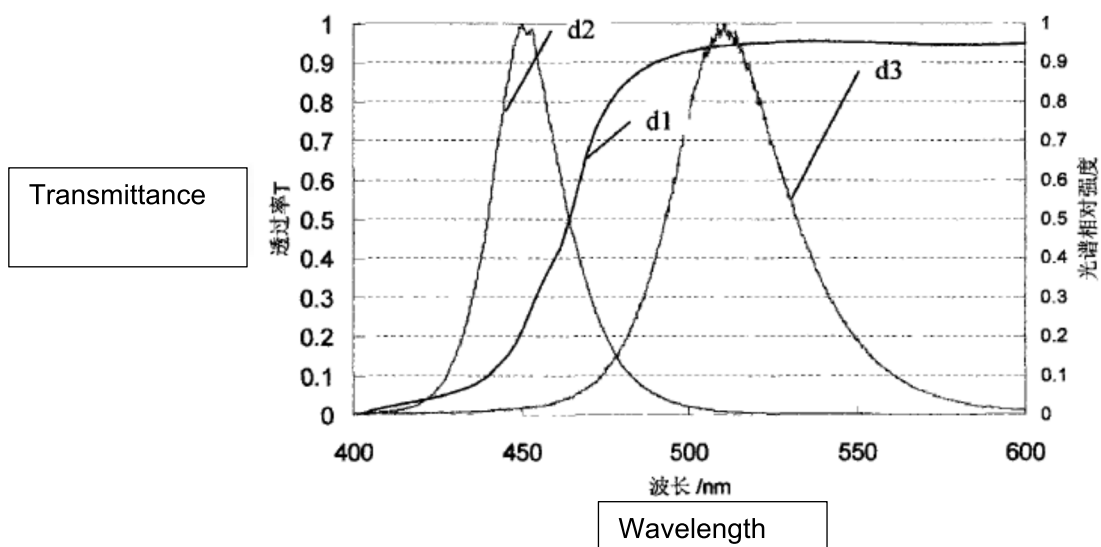


图 6

Figure 6

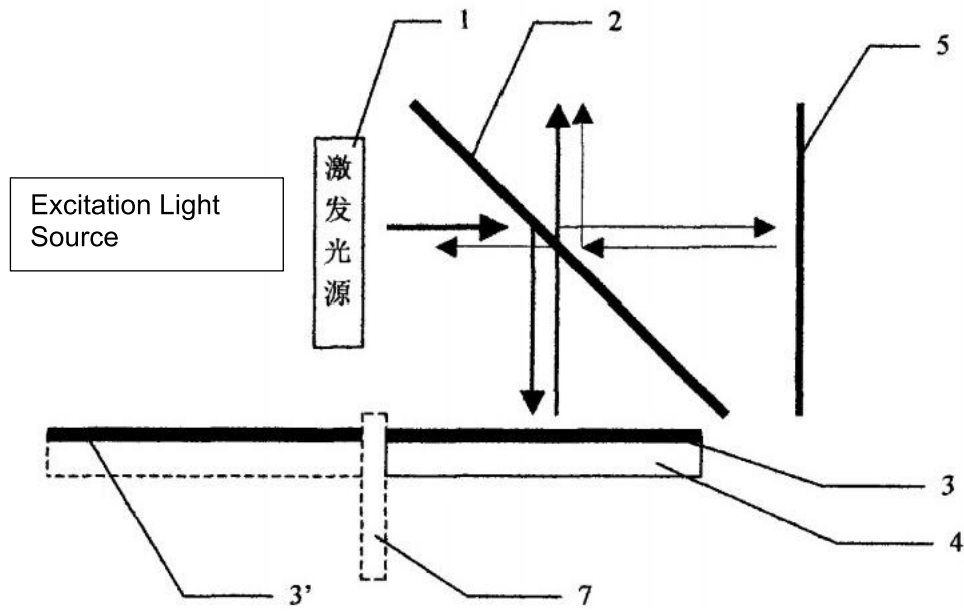
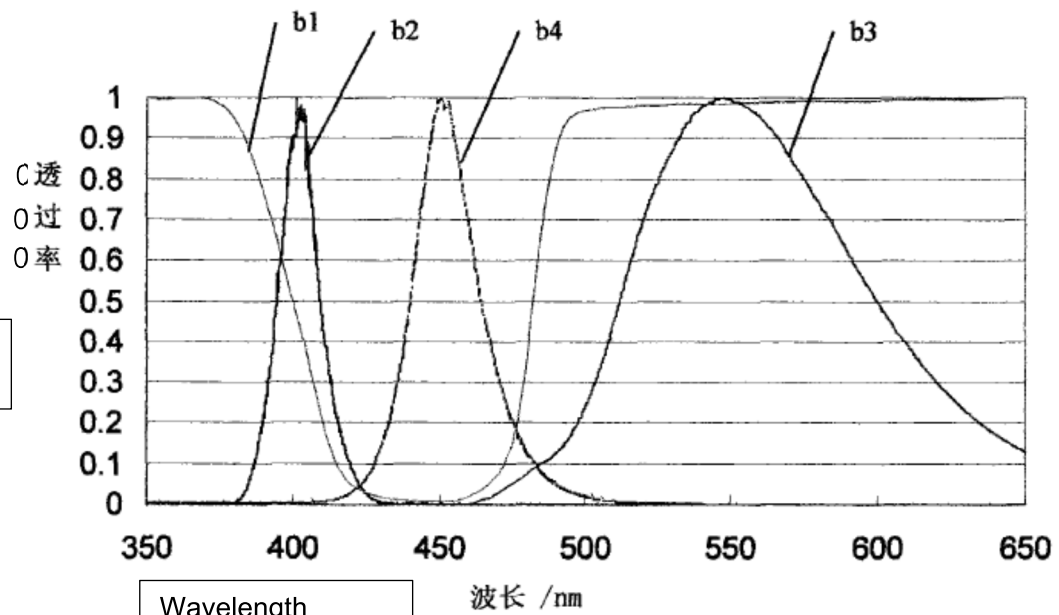


图 7

Figure 7



Wavelength

Figure 8