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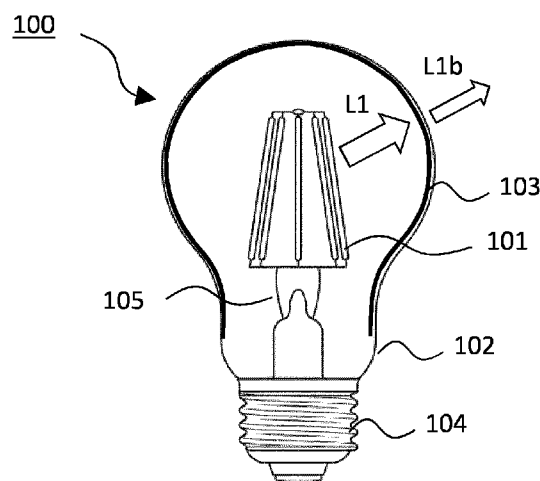


Fig. 1

(57) Abstract: There is provided a light emitting diode (LED) filament lamp (100) providing LED filament lamp light. The LED filament lamp comprises at least one LED filament (101) and an envelope (102). The at least one LED filament (101) comprises a carrier (106) which has an elongated body and a plurality of LEDs (107) mechanically coupled to the carrier (106). The at least one LED filament (101) is configured to emit LED filament light (L1). The LED filament light (L1) has a color point which is at least 12 SDCM below or above the black body line. The envelope (102) comprising a light absorbing filter (103). The at least one LED filament (101) is at least partly enclosed by the envelope (102). The light absorbing filter (103) has a variable wavelength dependent light absorption in the visible wavelength region. The light absorbing filter (103) is configured to absorb a first part (L1a) of LED filament light (L1) and to let pass a second part (L1b) of the LED filament light (L1). The second part (L1b) of the LED filament light (L1) is provided as the LED filament lamp light with a white light spectrum having a color point essentially on the black body line.



LED FILAMENT LAMP

FIELD OF THE INVENTION

The present invention generally relates to a light emitting diode (LED) filament lamp. The present invention further relates to a luminaire comprising said LED filament lamp.

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BACKGROUND OF THE INVENTION

Incandescent lamps are rapidly being replaced by LED based lighting solutions. It is nevertheless appreciated and desired by users to have retrofit lamps which have the look of an incandescent lamp. For this purpose, one can simply make use of the infrastructure for producing incandescent lamps based on a (glass) (envelope) and replace the filament with LEDs emitting white light. One of the concepts is based on LED filaments placed in such an envelope. The appearances of these lamps are highly appreciated as they look highly decorative.

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One of such LED based solutions is known from US 2012/0217862 A1, describing a lamp comprising a LED module having a translucent board in the shape of a plate and a plurality of LEDs mounted on the board such as to form two lines of LEDs. The LED module further comprises a sealing component for sealing the LEDs such that the lines of LEDs, when in operation, give the impression of a filament. The LED module further comprises lines, wiring and power supply for the LEDs.

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In order to improve the vintage look of these LED filament lamps the envelope is coated with an amber coating. However, this amber coating has a severe impact on the light quality.

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide a LED filament lamp that provides improved light quality. For example, the invention describes a colored LED filament lamp which provides a white light spectrum having a color point essentially on the black body line.

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What applies for the known amber coated lamp as described in the background section equally applies to other (slightly) colored lamps, for example lamps with red, blue, or orange colored transparent envelope, which apparently provide lamp light with a color point off-set from the black body line (BBL) (non-white light) due to the light absorbing filter on the lamp envelope.

The present invention discloses a LED filament lamp in accordance with the independent claim 1. Preferred embodiments are defined by the dependent claims.

According to a first aspect of the invention, a LED filament lamp is provided which comprises at least one LED filament and an envelope. The at least one LED filament comprises a carrier having an elongated body and a plurality of LEDs which are mechanically coupled to the carrier. The at least one LED filament is configured to emit LED filament light (L1). The LED filament light (L1) has a color point which is off the black body line. The envelope comprises a light absorbing filter. The at least one LED filament is at least partly enclosed by the envelope. The light absorbing filter having a variable wavelength dependent light absorption in the visible wavelength region. The light absorbing filter is configured to absorb a first part (L1a) of LED filament light and to let pass a second part (L1b) of the LED filament light. The second part of the LED filament light (L1b) is light with a white light spectrum which has a color point essentially on the black body line.

Hence the invention provides a LED filament lamp that is able to provide improved light quality. The reason is that instead of a LED filament providing a white light spectrum having a color point essentially on the black body line, a LED filament providing light having a color point which is off the black body line is used. Since the light absorbing filter provides a variable wavelength dependent light absorption in the visible wavelength region (i.e. has a colored appearance), a first part of the LED filament light is absorbed by the light absorbing filter and a second part of the LED filament light is passing the light absorbing filter such that the LED filament lamp is providing LED filament lamp light which has a white light spectrum with a color point essentially on the black body line. In other words, the gist of the invention is to purposely generate off-BBL light by the LED filament, which subsequently is corrected to on-BBL white light by the color filter. Thus by adding excess of light of a specific wavelength range (i.e. color e.g. blue light) (i.e. off-BBL light) and subsequently removing said excess by the light absorbing filter it is attained that in the off-state of the LED filament lamp it has a desired color (i.e. colored appearance), while in the on-state of the LED filament lamp it provides white light with a color point essentially on the BBL.

A LED filament lamp, for example, disclosed in US 2012/0217862 A1 which comprises a light absorbing filter which has a variable wavelength dependent light absorption in the visible wavelength region, is unable to provide white light spectrum with a color point essentially on the black body line. The reason is that a first part of the LED filament light which has a white light spectrum with a color point essentially on the black body line is absorbed by the light absorbing filter. A second part of the LED filament light is passing the light absorbing filter such that the LED filament lamp is providing LED filament lamp light which has a color point which is off the black body line.

Each spectral distribution has an accompanying color point x, y (CIE coordinates (especially CIE 1931 color space chromaticity)).

The LED filament lamp might have the feature that the light absorbing filter is arranged to transmit (substantially) all light of the visible spectrum range except in at least a first wavelength band. The first wavelength band is preferably a broad wavelength band. The broad wavelength band has at least a spectral width that is larger than 50 nanometers, the spectral width being expressed as a full width half maximum value (FWHM). This will result in a light absorbing filter with a good colored appearance.

The LED filament lamp might have the feature that the light absorbing filter is arranged to transmit substantially all light of the visible spectrum range except in at least a first wavelength band and a second wavelength band. The first wavelength band and/or second wavelength band is preferably a narrow wavelength band. The narrow wavelength band has at least a spectral width that is less than 50 nanometers, the spectral width being expressed as a full width half maximum value (FWHM). There may also be more than two light absorbing wavelength bands. This will result in a light absorbing filter with a good colored appearance.

The LED filament lamp might have the feature that the second part of the LED filament light (L1b) has a color temperature in a range from 2700 Kelvin to 5000 Kelvin and a color rendering index of at least 80. More preferably, the second part of the LED filament light (L1b) has a color temperature in a range from 2900 Kelvin to 5000 Kelvin and a color rendering index of at least 80. Most preferably, the second part of the LED filament light (L1b) has a color temperature in a range from 3000 Kelvin to 5000 Kelvin and a color rendering index of at least 80. The obtained effect is further improved light quality. The reason is that LED filament lamp light which has a higher color temperature and CRI is more impacted by the light absorbing filter. This means that the color point of the LED filament light (L1) needs to be further corrected and thus further away from the black body line.

The LED filament lamp might have the feature that the color point of the LED filament light (L1) is at least 12 SDCM (Standard Deviation of Colour Matching) below or above the black body line. More preferably, the color point of the LED filament light (L1) is at least 15 SDCM below the black body line. Most preferably, the color point of the LED filament light (L1) is at least 17 SDCM below the black body line. The obtained effect is that the light absorbing filter may have an intense/dark color appearance. The reason is that LED filament light (L1) which is further away from the BBL and may be more absorbed in a specific part of the visible wavelength range.

The LED filament lamp might have the feature that the color point of the second part of the LED filament light (L1b) is at least within 5 SDCM from the black body line. More preferably, the color point of the second part of the LED filament light (L1b) is at least within 4 SDCM from the black body line. Most preferably, the color point of the second part of the LED filament light (L1b) is at least within 3 SDCM from the black body line. The obtained effect is improved light quality. The reason is that light which is closer to the BBL is perceived as a higher quality.

The LED filament lamp might have the feature that the plurality of LEDs comprises blue LEDs for emitting blue light and/or UV LEDs for emitting UV light. The blue light emitted from the blue LEDs may be denoted as blue LED light. The UV light emitted from the UV LEDs may be denoted as UV LED light. The UV and/or blue LEDs may be combined with a luminescent material e.g. using a green/yellow and red phosphor.

The plurality of LEDs emits LED light. A luminescent material may at least partly convert LED light into converted light. The luminescent material may also reconvert converted light. The LED light and/or the (re)converted light forms the LED filament light.

The plurality of LEDs may comprise blue, yellow/green and red LEDs. The plurality of LEDs may also comprise UV, blue, yellow/green and red LEDs.

The plurality of LEDs may comprise blue and red LEDs in combination with a luminescent material. The plurality of LEDs may also comprise UV, blue and red LEDs in combination with a luminescent material. The luminescent material may be a green/yellow phosphor.

The luminescent material may comprise at least one of the following phosphors: a green phosphor, a yellow phosphor, an orange phosphor, a red phosphor.

The encapsulant may also comprise a scattering material. For example, BaSO₄, TiO₂, and/or Al₂O₃ may be used.

The LED filament lamp might have the feature that the plurality of LEDs comprises LEDs emitting blue light having a peak wavelength (λ_p) in a range from 420 to 490 nm. The obtained effect is further improved light quality. The reason is that light in this wavelength range is needed for making high quality white light.

5 The LED filament lamp might have the feature that the blue light has a spectral width that is less than 50 nanometers, the spectral width being expressed as a full width half maximum value. More preferably, the blue light has a spectral width that is less than 45 nanometers. Most preferably, the blue light has a spectral width that is less than 40 nanometers. The obtained effect is improved light quality. The reason is that blue light
10 having a narrow emission may be well absorbed by an amber colored light absorbing filter.

 The LED filament lamp might have the feature that the plurality of LEDs comprises LEDs emitting blue light having a peak wavelength (λ_p) in a range from 470 to 490 nm. Preferably, all blue LEDs in the plurality of LEDs have a peak wavelength (λ_p) in a range from 470 to 490 nm. The obtained effect is improved efficiency. The reason is that blue
15 light which has a peak wavelength (λ_p) in a range from 470 to 490 nm is less absorbed by an amber colored light absorbing filter compared to blue light which has a peak wavelength (λ_p) in below 470 nm such as for example 440 nm. In other words, the LED lamp (i.e. the light absorbing filter of the envelope) has a colored appearance, while less blue light is absorbed and thus improving the efficiency of the LED filament lamp.

20 The LED filament lamp might have the feature that the LED filament comprises an encapsulant at least partially enclosing the plurality of LEDs, wherein the encapsulant comprises a luminescent material. The obtained effect is providing a LED filament which better mimics a filament of an incandescent lamp. The reason is the encapsulant provides a continuous elongated body.

25 The LED filament lamp might have the feature that the LED filament comprises an encapsulant fully enclosing the plurality of LEDs, wherein the encapsulant comprises a luminescent material. The obtained effect is providing a LED filament which even better mimics a filament of an incandescent lamp. The reason is the encapsulant provides an improved continuous elongated body.

30 The LED filament lamp might have the feature that the LED filament comprises an encapsulant fully enclosing the plurality of LEDs and the carrier, wherein the encapsulant comprises a luminescent material. The obtained effect is providing a LED filament which even better mimics a filament of an incandescent lamp. The reason is the encapsulant provides a continuous elongated body.

The LED filament lamp might have the feature that the encapsulant is a polymer material such as for example a silicone material e.g. PDMS.

The LED filament lamp might have the feature that the carrier is a substrate. The carrier may be light transmissive. The carrier may be translucent. The carrier is preferably transparent to allow maximal light transmission (e.g. LED light and/or converted LED light) through the carrier. The carrier may be made of glass, sapphire, quartz, and/or a polymer.

The LED filament lamp might have the feature that the carrier comprises a first major surface and a second major surface arranged opposite to the first major surface.

An encapsulant may cover at least part of the first major surface and/or the at least part of the second major surface. An encapsulant may cover the first major surface and/or the second major surface. The encapsulant on the first major surface and/or the encapsulant on the second major surface may comprise a luminescent material. The luminescent material is configured to convert LED light into converted light and/or (re)convert converted light into converted light.

The LED filament lamp might have the feature that the luminescent material comprises: (i) a green phosphor which converts at least part of the blue light into green light, and (ii) a red phosphor which converts at least part of the blue light and/or green light into red light. The obtained effect is a low cost LED filament architecture. The reason is that only blue LEDs are needed because green and red light is made by phosphor conversion.

The LED filament lamp might have the feature that the luminescent material comprises: (i) a blue phosphor which converts at least part of UV light emitted by a UV LED into blue light, (ii) a green phosphor which converts at least part of the UV light emitted by the UV LED or blue light into green light, and (iii) a red phosphor which converts at least part of the UV light emitted by the UV LED and/or blue light and/or green light into red light. The obtained effect is a low cost LED filament architecture. The reason is that only UV LEDs are needed because blue, green and red light is made by phosphor conversion. It goes without saying that also UV and blue LEDs may be combined.

The LED filament lamp might have the feature that the LED filament may also comprise red LEDs. The obtained effect is improved efficiency. The reason is that if red LEDs are used a narrow red peak is obtained i.e. thus no long tail in the far red which is less visible for the humans. For example the carrier may carry red LEDs (R) and blue LEDs (B) in the following order: B-R-B-R etc. or BB-R-BB-R etc.

The LED filament lamp might have the feature that the green light has a spectral width that is larger than 50 nanometers, the spectral width being expressed as a full width half maximum value. More preferably, the green light has a spectral width that is larger than 60 nanometers. Most preferably, the green light has a spectral width that is larger than 65 nanometers. The obtained effect is improved light quality. The reason is that light in this wavelength range and spectral distribution is needed for making very high quality white light. In this way a good CRI can be obtained.

The LED filament lamp might have the feature that the light absorbing filter has an averaged absorption within a blue color range (Ab), an averaged absorption within a green color range (Ag), and an averaged absorption within a red color range (Ar). The Ab is at least two times the Ag and Ab is at least three times Ar. The obtained effect is a good color appearance of the light absorbing filter. The reason is a higher contrast in light absorption in the different color wavelength ranges.

The LED filament lamp might have the feature that the light absorbing filter having an averaged absorption within a blue color range (Ab), an averaged absorption within a green color range (Ag), and an averaged absorption within a red color range (Ar). The Ab is at least four times the Ag and Ab is at least five times Ar. The obtained effect is a very good color appearance of the light absorbing filter. The reason is an even higher contrast in light absorption in the different color wavelength ranges.

The LED filament lamp might have the feature that Ab is at least 20 %. More preferably, Ab is at least 25 %. Most preferably, Ab is at least 30 % or Ab is at least 35 %. The obtained effect is a very good color appearance of the light absorbing filter. The reason is that a large amount blue light is absorbed.

The LED filament lamp might have the feature that the envelope is the light absorbing filter. For example, the envelope may be made of an envelope material such as for example glass or a polymer (e.g. PC, PET, PE, PMMA, PTFE, silicone). A light absorbing material may be dispersed or molecularly dissolved in the envelope material. The envelope may be arranged at a distance different from zero from the at least one LED filament. The envelope may be connected to the cap of the envelope. The distance may be at least 1 cm.

The LED filament lamp might have the feature that the light absorbing filter may be applied to the envelope e.g. as a layer and/or coating. For example, the coating comprises a coating material such as a polymer (e.g. based on PVA). A light absorbing material may be dispersed in the coating material.

The LED filament lamp might have the feature that the light absorbing filter has an amber color. The obtained effect is improved vintage look of the LED filament lamp. The reason is that the amber coating is perceived as an vintage color. Other colors may be possible as well. E.g. green or red colored lamps that merge into the background or lamp shade when turned off, but when on issue white light.

The LED filament lamp might have the feature that the envelope is fully covered with the light absorbing filter. The obtained effect is improved vintage look of the lamp. The reason is the LED filaments are only visible through the light absorbing filter.

The LED filament lamp might have the feature that the light absorbing filter is clearly transparent i.e. non-diffusing. The obtained effect is improved vintage look of the lamp. The reason is that the LED filaments are very well visible. Clearly transparent maybe substantial transparent such that the LED filaments are very well visible.

The LED filament lamp has the feature that the second part (L1b) of the LED filament light (L1) may be emitted as LED filament lamp light.

Hence, by the invention an improved LED filament lamp is provided. The LED filament lamp comprises at least one LED filament and an envelope. The at least one LED filament comprising a carrier which has an elongated body and a plurality of LEDs mechanically coupled to the carrier. The at least one LED filament is configured to emit LED filament light (L1). The LED filament light (L1) has a color point which is off the black body line. The envelope comprises a light absorbing filter. The at least one LED filament is at least partly enclosed by the envelope. The light absorbing filter modifies the LED filament light passing through said light absorbing filter such that light to be issued from the LED filament lamp as lamp light has a white light spectrum which has a color point essentially on the black body locus.

The LED filament light may comprises blue light, green light, and red light. The LED filament may comprise blue LED light and/or converted blue light (i.e. UV light which is converted to blue light), green LED light and/or converted green light (i.e. UV and/or blue light which is converted to green light), and red LED light and/or converted red light (i.e. UV and/or blue light and/or green light which is converted to red light).

The present invention discloses a luminaire in accordance with claim 15.

The LED filament lamp might have the feature that the luminaire comprises the LED filament lamp. The obtained effect is a luminaire with a vintage look is obtained. The reason is that the LED filament lamp may be visible through the light exit of the luminaire.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

Fig. 1 shows a schematic view a LED filament lamp according to an embodiment of the present invention; and

Fig. 2 shows a schematic view of a LED filament according to an embodiment of the present invention; and

Fig. 3 shows a correlated color diagram according to an embodiment of the present invention; and

Fig. 4 shows an intensity as function of the wavelength according to an embodiment of the present invention; and

Fig. 5 shows a transmission as function of the wavelength according to an embodiment of the present invention; and

Fig. 6 shows a schematic view of a cross section of the LED filament according to an embodiment of the present invention; and

Fig. 7 shows a schematic view of a luminaire according to an embodiment of the present invention; and

Fig. 8 shows a graph of the relative intensity as a function of the wavelength according to an embodiment of the present invention; and

Fig. 9 shows a CCT diagram according to an embodiment of the present invention.

The schematic drawings are not necessarily on scale.

The same features having the same function in different figures are referred to the same references.

DETAILED DESCRIPTION

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness, and fully convey the scope of the invention to the skilled person.

Fig. 1 shows a schematic view a LED filament lamp 100 according to an embodiment of the present invention. As depicted in Fig. 1, the LED filament lamp 100 providing LED filament light and comprises at least one filament 101 and an envelope 102. The LED filament lamp may comprise two, three, four, five, six, seven, eight or more LED filaments 101.

Fig. 2 shows a schematic view of a LED filament 101 according to an embodiment of the present invention. As depicted in Fig. 2, the LED filament comprises a carrier 106 which has an elongated body and a plurality of LEDs 107 mechanically coupled to the carrier 106. The at least one LED filament 101 is configured to emit LED filament light L1. The LED filament light L1 has a color point which is off the black body line. The plurality of LEDs 107 may be arranged along a line in a direction parallel to the longest axis of the carrier 106. The plurality of LEDs 107 may be connected in series and/or parallel connection. The plurality of LEDs may be connect via electrical conductive wiring and/or tracks 108.

Referring back to Fig. 1, the envelope 102 comprises a light absorbing filter 103. The at least one LED filament 101 is at least partly enclosed by the envelope 102. The light absorbing filter 103 has a variable wavelength dependent light absorption in the visible wavelength region. The light absorbing filter 103 is configured to absorb a first part L1a of LED filament light L1 (e.g. the blue wavelength range of the visible wavelength range) and to let pass a second part L1b of the LED filament light L1 (e.g. the green and red wavelength ranges of the visible wavelength range). The second part L1b of the LED filament light L1 is provided as LED filament lamp light with a white light spectrum having a color point essentially on the black body line. A variable wavelength dependent light absorption in the visible wavelength region is a non-uniform light absorption in the visible wavelength region.

Referring back to Fig. 1, the LED filament lamp 100 comprises a cap 104. The cap 104 is configured to electrically and mechanically connect the LED filament lamp 100 to a socket of a luminaire (not shown). The cap may be electrically connected to the LED filament 101 via a LED driver (not shown). The LED driver is positioned e.g. in the cap 104. The cap 104 may be electrically connected to the LED filament 101 via a LED driver and a LED controller (not shown). The LED filament lamp 100 may comprise a holding means 105 for mechanically holding the LED filament 101. The holding means 105 may be mechanically connected to the cap 104 or inner side of the envelope 102. The envelope 102 may be dome shaped.

Fig. 3 shows a correlated color diagram according to an embodiment of the present invention. As depicted in Fig. 3, the correlated color diagram shows the color point of the blue light cpB, the color point of the green light cpG, the color point of the red light cpR, the color point of the LED filament light L1, and the color point of the second part L1b of the LED filament light L1. As depicted in Fig. 3, the light absorbing filter 103 is configured to absorb a first part L1a of LED filament light L1 and to let pass a second part L1b of the LED filament light L1. In this way one moves from cpL1 to cpL1b. In this example, cpL1b is light with a white spectrum on the BBL at 2360 K.

Fig. 4 shows an intensity as function of the wavelength according to an embodiment of the present invention. As depicted in Fig. 4, the graph shows intensity as function of wavelength for LED filament light L1 and second part L1b of the LED filament light L1. LED filament light L1 with too much blue is emitted by the LED filament 101. In case of an amber colored light absorbing filter 103, blue light is being absorbed by the light absorbing filter 103. It results in a decrease in blue light as indicated by the second part L1b of the LED filament light L1.

The second part L1b of the LED filament light L1 may have a color temperature in a range from 2700 Kelvin to 5000 Kelvin and a color rendering index of at least 80.

The color point of the LED filament light L1 may be at least 12 SDCM below the black body line.

The color point of the second part L1b of the LED filament light L1 may be at least within 5 SDCM from the black body line (i.e. a color point essentially on the black body line).

The plurality of LEDs 107 may comprise LEDs emitting blue light having a peak wavelength λ_p in a range from 420 to 490 nm.

The plurality of LEDs 107 may comprise LEDs emitting blue light having a peak wavelength λ_p in a range from 470 to 490 nm.

Fig. 5 shows a transmission as function of the wavelength according to an embodiment of the present invention. As depicted in Fig. 5, this type of light absorbing filter 103 is not/slightly transparent in the blue color range, but transparent in the green color range and the red color range. This type of light absorbing filter 103 has an amber color. This type of light absorbing 103 predominantly absorbs light in the blue color range, and does (almost) not absorb light in the green color range and red color range.

Fig. 6 shows a schematic view of a cross section (C, along the diameter of the LED filament) of the LED filament 101 according to an embodiment of the present invention. As depicted in Fig. 6, the LED filament 101 comprises an encapsulant 109 at least partially enclosing the plurality of LEDs 107. The encapsulant 109 comprises a luminescent material 110.

The luminescent material 110 may comprise: (i) a green phosphor which converts at least part of the blue light into green light, and (ii) a red phosphor which converts at least part of the blue light and/or green light into red light.

The green light may have a spectral width that is larger than 50 nanometers, the spectral width being expressed as a full width half maximum value FWHM.

The light absorbing filter 103 may have an averaged absorption within a blue color range Ab, an averaged absorption within a green color range Ag, and an averaged absorption within a red color range Ar. The Ab may be at least two times the Ag and Ab may be at least three times Ar.

The light absorbing filter 103 may have an averaged absorption within a blue color range Ab, an averaged absorption within a green color range Ag, and an averaged absorption within a red color range Ar. The Ab may be at least four times the Ag and Ab may be at least five times Ar.

Ab may be at least 20 %. More preferably, Ab may be at least 25 %. Most preferably, Ab may be at least 30 % or Ab may be at least 35%.

The light absorbing filter 103 may have an amber color. The light absorbing filter 103 may have a green, yellow, orange or red color. A light absorbing filter having an amber color is perceived as a highly vintage look.

The envelope 102 may be fully covered with the light absorbing filter 103.

The envelope 102 may be partially covered with the light absorbing filter 103 e.g. the neck of the envelope 102 may not be covered with the light absorbing filter 103.

Fig. 7 shows a schematic view of a luminaire according to an embodiment of the present invention. As depicted in Fig. 7, a luminaire 200 comprises the LED filament lamp 100.

Fig. 8 shows a graph of the relative intensity as a function of the wavelength according to an embodiment of the present invention. Fig. 9 shows a CCT diagram. As depicted in Fig. 8, the at least one LED filament 101 is configured to emit LED filament light L1. In case the light absorbing filter 103 having a variable wavelength dependent light absorption in the visible wavelength region according to Fig. 5 is used (i.e. a higher

absorption in the blue wavelength range than in the green-yellow and red wavelength range), the light absorbing filter 103 will absorb a first part L1a of LED filament light L1 and to let pass a second part L1b of the LED filament light L1 as is shown in Fig. 8. As depicted in CCT diagram in Fig. 9, the second part L1b of the LED filament light L1 is light with a white light spectrum having a color point essentially on the black body line at 3000 K. The color point of the second part L1b of the LED filament light L1 is within 5 SDCM from the black body line. As depicted in Fig. 9, the color point of the LED filament light L1 is at least 15 SDCM below the black body line.

The light emitting diode may also be a laser diode.

The visible wavelength range is in the range from 400 to 800 nm. The blue color range is in the wavelength range from 420 to 490 nm. The green (and yellow) color range is in the wavelength range from 490 to 590 nm. The red (and orange) color range is in the wavelength range from 590 to 780 nm.

What applies for the known incandescent lamp as described in the background section equally applies to other conventional light sources such as for example GLS or halogen lamps.

The terms “variable wavelength dependent light absorption” and “non-uniform light absorption” refers to that the degree of light absorption is (significantly) different for at least two different wavelengths or wavelength ranges of the visible light. Significant means that for at least two different wavelengths or wavelength ranges there is a difference in absorption of at least 10%, or at least 20%, or at least 30%.

The term “substantially” herein, such as in “substantially all light” or in “substantially consists”, will be understood by the person skilled in the art. The term “substantially” may also include embodiments with “entirely”, “completely”, “all”, etc.

Hence, in embodiments the adjective substantially may also be removed. Where applicable, the term “substantially” may also relate to 90% or higher, such as 95% or higher, especially 99% or higher, even more especially 99.5% or higher, including 100%. The term “comprise” includes also embodiments wherein the term “comprises” means “consists of”. The term “and/or” especially relates to one or more of the items mentioned before and after “and/or”. For instance, a phrase “item 1 and/or item 2” and similar phrases may relate to one or more of item 1 and item 2. The term “comprising” may in an embodiment refer to “consisting of” but may in another embodiment also refer to “containing at least the defined species and optionally one or more other species”. Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and

not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein. The devices herein are amongst others described during
5 operation. As will be clear to the person skilled in the art, the invention is not limited to methods of operation or devices in operation.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any
10 reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably
15 programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

The invention further applies to a device comprising one or more of the
20 characterizing features described in the description and/or shown in the attached drawings. The invention further pertains to a method or process comprising one or more of the characterizing features described in the description and/or shown in the attached drawings.

The various aspects discussed in this patent can be combined in order to provide additional advantages. Further, the person skilled in the art will understand that
25 embodiments can be combined, and that also more than two embodiments can be combined. Furthermore, some of the features can form the basis for one or more divisional applications.

CLAIMS:

1. A light emitting diode, LED, filament lamp (100) providing LED filament lamp light, comprising:
 - at least one LED filament (101) comprising a carrier (106) having an elongated body and a plurality of LEDs (107) mechanically coupled to the carrier (106), the
 - 5 at least one LED filament (101) is configured to emit LED filament light (L1), the LED filament light (L1) having a color point which is at least 12 SDCM below or above the black body line;
 - an envelope (102) comprising a light absorbing filter (103), the at least one LED filament (101) is at least partly enclosed by the envelope (102);
 - 10 - wherein the light absorbing filter (103) has a variable wavelength dependent light absorption in the visible wavelength region;
 - wherein the light absorbing filter (103) is configured to absorb a first part (L1a) of LED filament light (L1) and to let pass a second part (L1b) of the LED filament light (L1);
 - 15 - wherein the second part (L1b) of the LED filament light (L1) is provided as the LED filament lamp light with a white light spectrum having a color point essentially on the black body line.
2. The LED filament lamp (100) according to claim 1, wherein the second part (L1b) of the LED filament light (L1) has a color temperature in a range from 2700 Kelvin to 5000 Kelvin and a color rendering index of at least 80.
3. The LED filament lamp (100) according to any one of the preceding claims, wherein the color point of the LED filament light (L1) is at least 12 SDCM below the black
- 25 body line.
4. The LED filament lamp (100) according to any one of the preceding claims, wherein the color point of the second part (L1b) of the LED filament light (L1) is at least within 5 SDCM from the black body line.

5. The LED filament lamp (100) according to any one of the preceding claims, wherein the plurality of LEDs (107) comprises LEDs emitting blue light having a peak wavelength (λ_p) in a range from 420 to 490 nm.

5

6. The LED filament lamp (100) according to any one of the preceding claims, wherein the plurality of LEDs (107) comprises LEDs emitting blue light having a peak wavelength (λ_p) in a range from 470 to 490 nm.

10 7. The LED filament lamp (100) according to any one of the preceding claims, wherein the LED filament (101) comprises an encapsulant (109) at least partially enclosing the plurality of LEDs (107), wherein the encapsulant (109) comprises a luminescent material (110).

15 8. The LED filament lamp (100) according to claim 7, wherein the plurality of LEDs comprise blue LEDs and the luminescent material (110) comprises:

- a green phosphor converting at least part of the blue light into green light, and
- a red phosphor converting at least part of the blue light and/or green light into red light.

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9. The LED filament lamp (100) according to claim 8, wherein the green light having a spectral width that is larger than 50 nanometers, the spectral width being expressed as a full width half maximum value (FWHM).

25 10. The LED filament lamp (100) according to any one of the preceding claims, wherein the light absorbing filter (103) has an amber color.

11. The LED filament lamp (100) according to any one of the preceding claims, wherein the light absorbing filter (103) having an averaged absorption within a blue color range (A_b), an averaged absorption within a green color range (A_g), an averaged absorption within a red color range (A_r), wherein the A_b is at least two times the A_g and A_b is at least three times A_r .

30

12. The LED filament lamp (100) according to any one of claims 1 to 10, wherein the light absorbing filter (103) having an averaged absorption within a blue color range (Ab), an averaged absorption within a green color range (Ag), an averaged absorption within a red color range (Ar), wherein the Ab is at least four times the Ag and Ab is at least five times Ar.

5

13. The LED filament lamp (100) according to claim 11 and/or claim 12, wherein Ab is at least 20 %.

14. The LED filament lamp (100) according to any one of the preceding claims,
10 wherein the envelope (102) is fully covered with the light absorbing filter (103).

15. A luminaire (200) comprising the LED filament lamp (100) according to any one of the preceding claims.

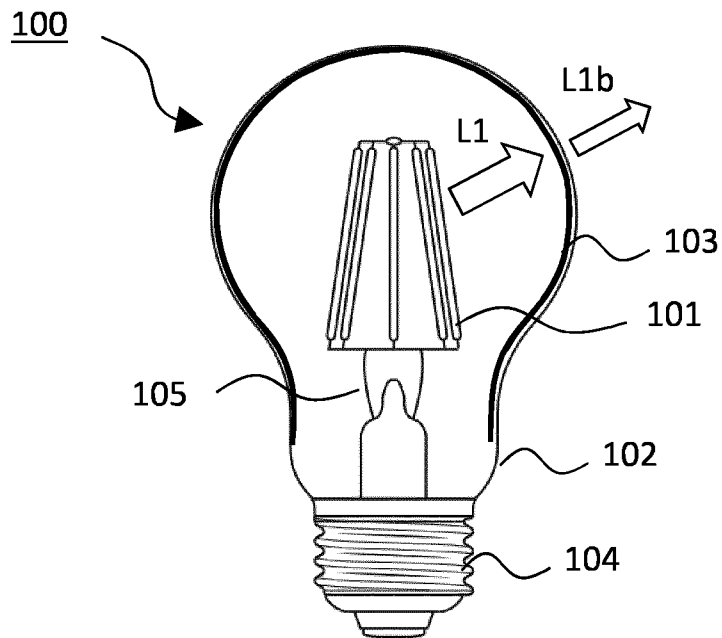


Fig. 1

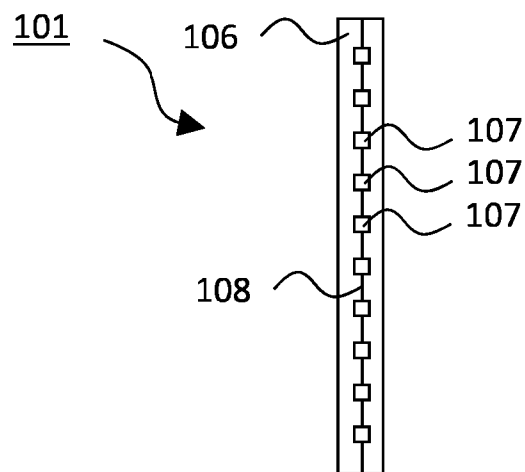


Fig. 2

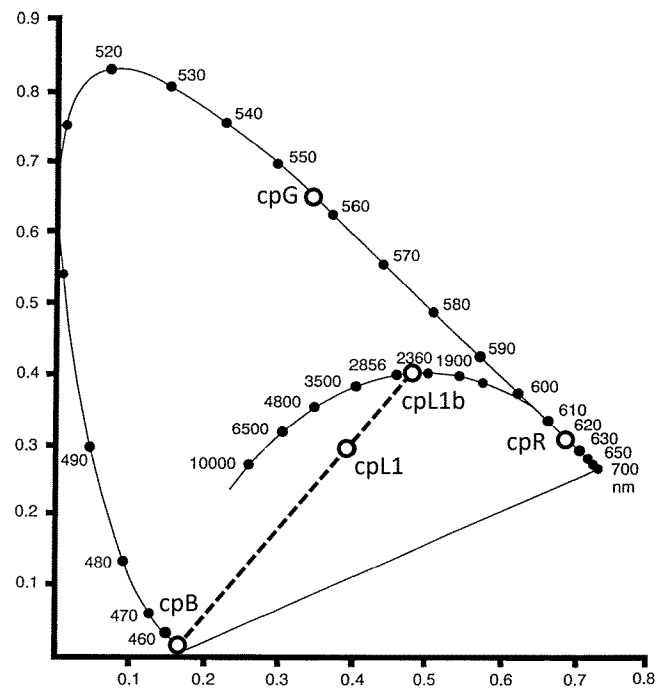


Fig. 3

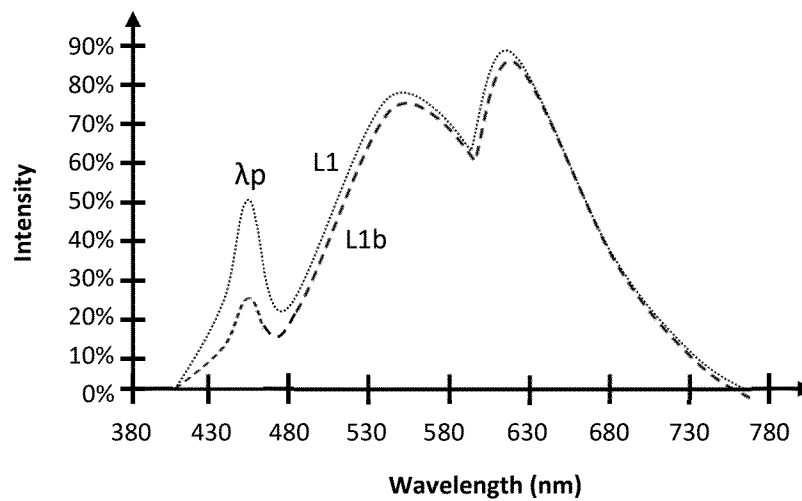


Fig. 4

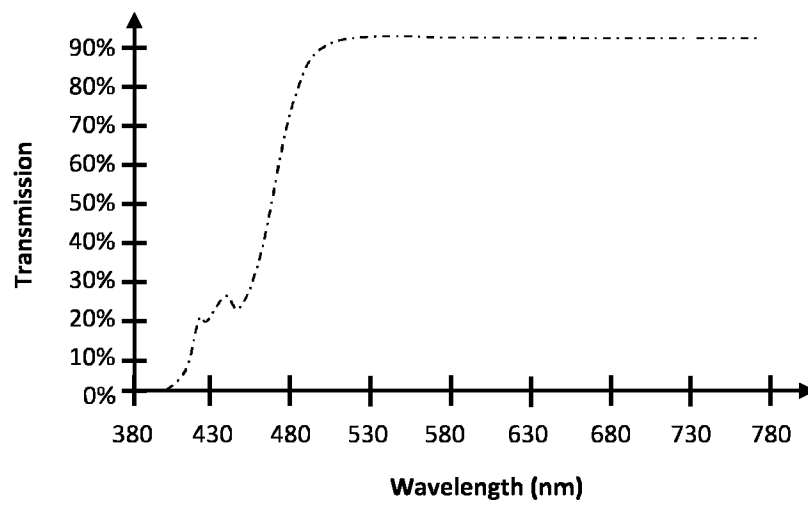


Fig. 5

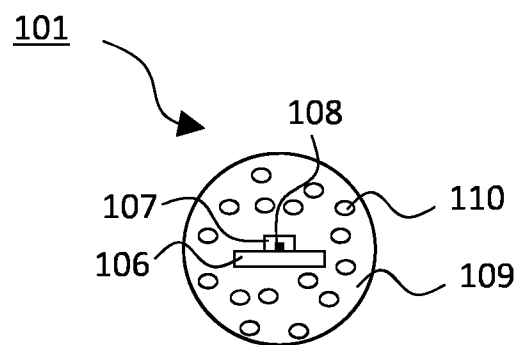


Fig. 6

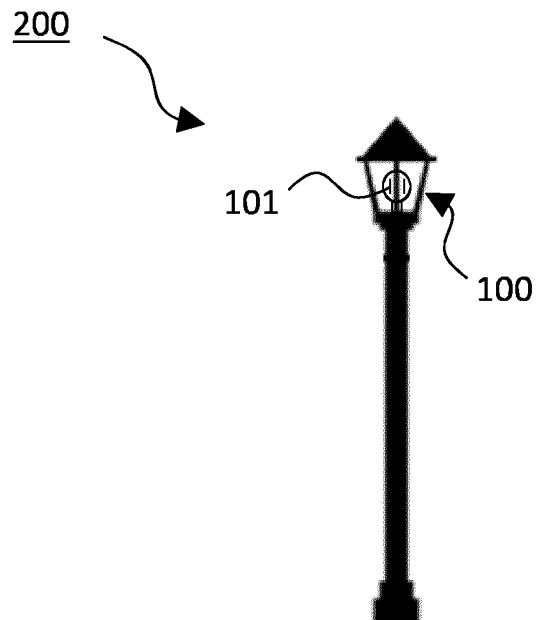


Fig. 7

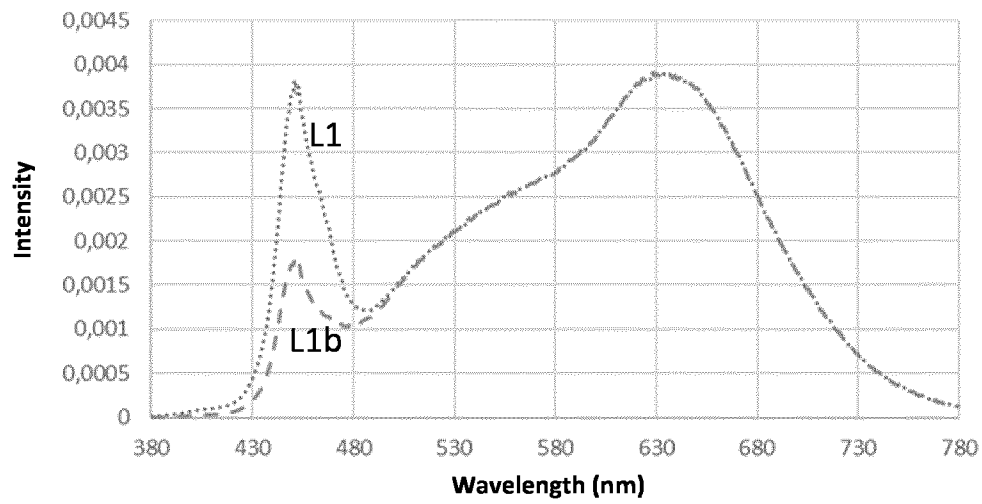


Fig. 8

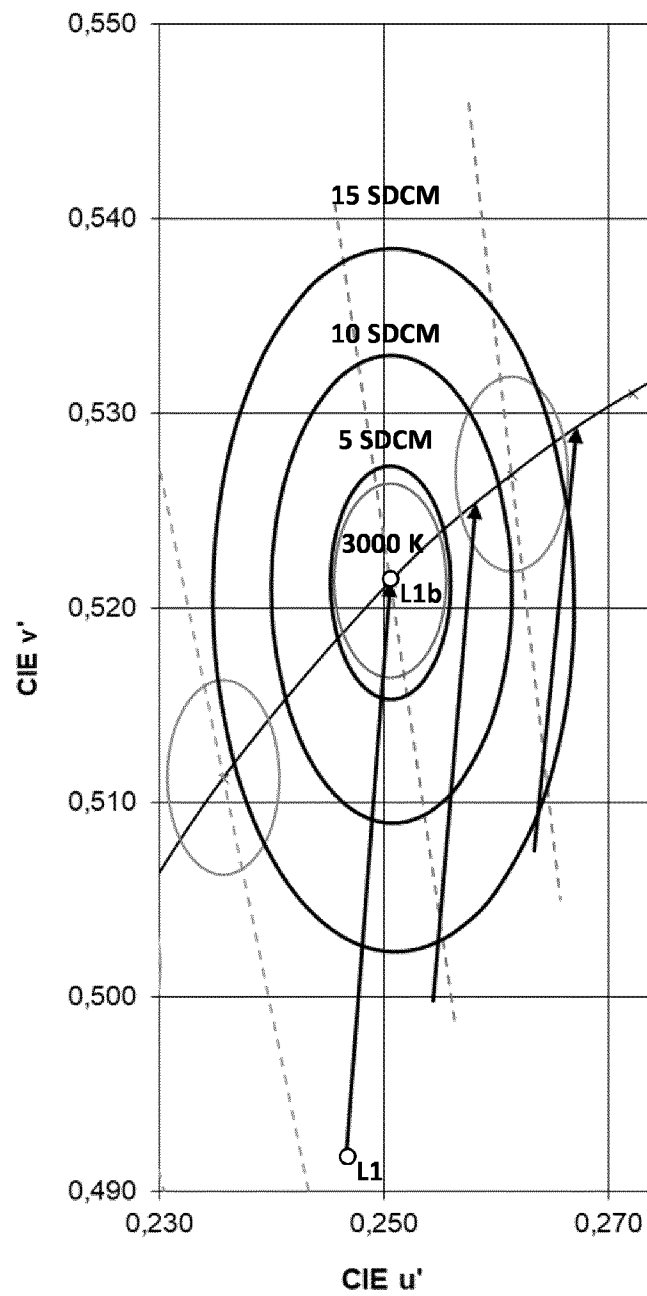


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/066451

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21K9/232 F21V9/02 F21S4/20 H05B33/08
ADD. F21Y113/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21K F21V F21S F21Y H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018/031185 A1 (PETTMANN MARC [FR]) 1 February 2018 (2018-02-01) paragraphs [0006] - [0009], [0017] - [0027], [0104] - [0139]; figures 1-4, 12-14	1-15
A	----- Anonymous: "Light-emitting diode - Wikipedia", 22 November 2016 (2016-11-22), XP055322532, Retrieved from the Internet: URL: https://en.wikipedia.org/wiki/Light-emitting_diode [retrieved on 2016-11-24] page 11 -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

9 August 2019

Date of mailing of the international search report

22/08/2019

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Authorized officer

Waters, Duncan

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/066451

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018031185	A1	01-02-2018	EP 3286491 A1 28-02-2018
			FR 3034838 A1 14-10-2016
			US 2018031185 A1 01-02-2018
			WO 2016162616 A1 13-10-2016
