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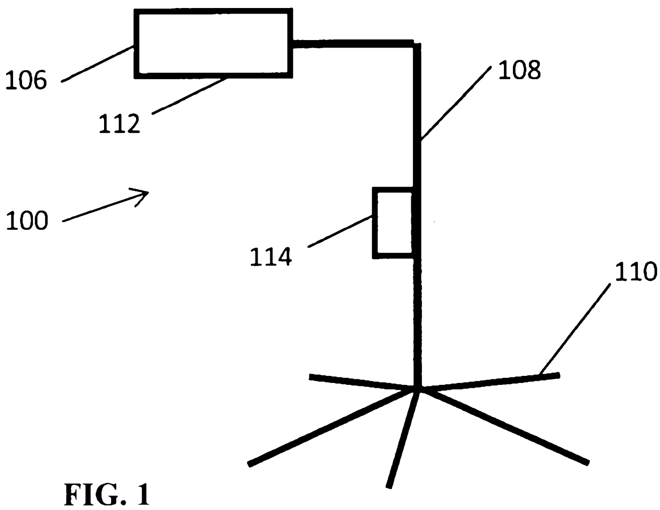

FIG. 1

(57) Abstract: Disclosed herein are devices, systems, and methods for providing light therapy to a subject's tissues. The devices, systems, and methods include a phototherapeutic lamp comprising light generating sources that emit light capable of causing a medical and/or cosmetic treatment of tissues. Also included are uses of the devices. The devices and methods may also include a photoactivatable composition.

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PHOTOTHERAPEUTIC DEVICE, METHOD AND USE

BACKGROUND OF THE DISCLOSURE

Phototherapy relates to treatment of biological tissues using electromagnetic radiation such as visible and infrared lights. It has a wide range of applications in both the medical and cosmetic fields including skin rejuvenation and treatment of various skin conditions. Phototherapy has also been used in combination with certain photo-sensitive drugs or photoactive compositions. It is desired to provide a novel phototherapy device and method having cosmetic or medical uses.

SUMMARY

There is broadly provided a device for phototherapy, and a method and use of the device and which comprises light having different and complementary therapeutic effects to treat a variety of different conditions in a subject, which may be human or animal.

Different aspects of the device broadly comprise at least one light source which can emit light having an emission spectra which can have one or more of the following properties: (i) produce an antimicrobial effect on a treatment area irradiated with the emitted light, (ii) modulate blood flow in the treatment area, and/or (iii) activate a photoactivatable composition comprising at least one chromophore/fluorochrome which may then emit a light (fluorescence or phosphorescence) with therapeutic properties such as modulating blood flow in the treatment area, collagen modulation and/or which can release bio-therapeutic reactive species, such as singlet oxygen, onto, into or nearby the treatment area.

From one aspect, there is provided a device for phototherapy comprising: a first light source which can emit a first light having an emission spectra for activating a photoactivatable composition applied on or near a treatment area; and a second light source which can emit a second light having a different emission spectra from the first, wherein the first and the second emission spectra are in the blue and/or violet regions of the electromagnetic spectrum. In certain embodiments, the first light is in the violet region of the electromagnetic spectrum and the second light is in the blue region of the electromagnetic spectrum.

From another aspect, there is provided a device for phototherapy comprising: a first light source which can emit a first light having a first emission spectra; and a second light source which can emit a second light having a second emission spectra which is different from the first, wherein the first and the second emission spectra are in the blue and/or violet regions of the electromagnetic spectrum. In certain embodiments, the first light is in the blue region of the electromagnetic spectrum and the second light is in the violet region of the electromagnetic spectrum.

From another aspect, there is provided a device for phototherapy comprising: a first light source which can emit a first light having a first peak wavelength for activating a photoactivatable composition applied on or near a treatment area; and a second light source which can emit a second light having a second peak wavelength which is different from the first peak wavelength, wherein the first and the second peak wavelengths are in the blue and/or violet regions of the electromagnetic spectrum.

From another aspect there is provided a device for phototherapy comprising: a first light source which can emit a first light having a first peak wavelength; and a second light source which can emit a second light having a second peak wavelength which is different from the first peak wavelength, wherein the first peak wavelength is in the blue and/or violet regions of the electromagnetic spectrum.

In certain embodiments, the first light has a peak wavelength (first peak wavelength) of about 430 to about 500 nm, about 440 to about 500 nm, about 450 to about 500 nm, about 430 to about 475 nm, about 435 nm to about 470 nm, about 440 nm to about 460 nm, about 440 nm, about 450 nm, about 460 nm or about 470 nm. In certain embodiments, the second light has a peak wavelength (second peak wavelength) of about 400 nm to about 500 nm, about 400 nm to about 475 nm, about 400 nm to about 450 nm, about 400 nm to about 430 nm, or about 410 nm to about 420 nm, or about 415 nm. In one embodiment, the second peak wavelength is from about 410 nm to about 430 nm, and the peak wavelength of the first light is from about 440 nm to about 470 nm.

Alternatively, the second peak wavelength can be about 480 to about 760 nm, about 480 nm to about 700 nm, about 480 nm to about 650 nm, about 480 nm to about 620 nm, about 500 to about 700 nm, about 520 nm to about 700nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm, about 540 nm to about 580 nm, about 500 nm to about 570 nm, about 570 nm to about 590 nm, about 590 nm to about 610 nm, about 610 nm to about 760 nm, or within the infrared range of the electromagnetic spectrum.

In certain embodiments, the second peak wavelength is longer than the first peak wavelength. The distance between the first and the second peak wavelength may be due to a Stoke's shift.

At least one of the first and second lights can have a bandwidth (full width half maximum) of equal to or less than about 20nm, or about 19nm ± 5 nm (14 nm to 24 nm). In certain embodiments, the second light has a bandwidth of between about 15 nm and about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

In certain embodiments, the second light has a bandwidth which is broader than a bandwidth of the first light. The bandwidth of the first light can be about 15 nm to about 25 nm and the bandwidth of the second light can be about 20 nm to about 100 nm.

In certain embodiments, an average power density of the light emitted by the device and/or received by the treatment area, measured at a treatment distance (such as 5 cm or 10 cm), is less than about 200 mW/cm^2, about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 200 mW/cm^2, about 10 to about 150 mW/cm^2, 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, or about 110 to about 135 mW/cm^2. In some embodiments, an average power density of the light emitted by the device is about 4 to about 75 mW/cm^2, about 10 to about 75 mW/cm^2, about 10 to about 85 mW/cm^2, about 15 to about 75 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 mW/cm^2 to about 70 mW/cm^2, about 55 to about 85 mW/cm^2, or about 55 to about 65 mW/cm^2.

In certain embodiments, an average power density of the second light is lower than an average power density of the first light. For example, the average power density of the second light may be about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

In some embodiments, the average power density of the second light may be less than about 75 mW/cm^2, less than about 50 mW/cm^2, less than about 10 mW/cm^2, less than about 5 mW/cm^2, less than about 2.5 mW/cm^2, or less than about 2 mW/cm^2. The power density at the peak wavelength can be from about 0.02 $mW/cm^2/nm$ to about 75 $mW/cm^2/nm$, from about 0.02 to about 50 $mW/cm^2/nm$, from about 0.02 to about 10 $mW/cm^2/nm$, from about 0.02 to about 5 $mW/cm^2/nm$, or from about 0.02 to about 10 $mW/cm^2/nm$, about 0.005 to about 10 $mW/cm^2/nm$, about 0.01 to 0.1 $mW/cm^2/nm$, about 0.01 to about 2 $mW/cm^2/nm$, about 0.01 to about 3 $mW/cm^2/nm$, or about 0.5 to about 5 $mW/cm^2/nm$.

In certain embodiments, the device is arranged to modulate the emitted light source over a period of light emission from the device, for example a decrease in emitted power density over time. The power density may be decreased at any rate, for example at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute. In certain embodiments, the second light source emits light which approximately or substantially mimics an emitted fluorescence or phosphorescence light from any fluorescent or phosphorescent agent. In one embodiment, the second source emits light which is similar to that emitted by Eosin Y or Eosin Y and Fluorescein when photoactivated. The fluorescence or phosphorescence light may be within the visible or infrared portions of the electromagnetic spectrum, such as green, yellow and orange.

In certain embodiments, an average fluence emitted by the device and/or received by the treatment area, during a single treatment, is more than about 4 J/cm^2, more than about 10 J/cm^2, more than about 15 J/cm^2, more than about 30 J/cm^2, more than about 50 J/cm^2, up to about 60 J/cm^2. In certain embodiments, the device is arranged to emit light having a fluence, during a single treatment, of about 4 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 50 J/cm^2, about 10 J/cm^2 to about 40 J/cm^2, about 10 J/cm^2 to about 30 J/cm^2, about 20 J/cm^2 to about 40 J/cm^2, about 15 J/cm^2 to about 25 J/cm^2, or about 10 J/cm^2 to about 20 J/cm^2.

The treatment time may range from about 30 seconds to about 25 minutes, about 30 seconds to 20 minutes, about 30 seconds to 19 minutes, about 30 seconds to 18 minutes, about 30 seconds to 19 minutes, about 30 seconds to 17 minutes, about 30 seconds to 16 minutes, about 30 seconds to 15 minutes, about 30 seconds to 14 minutes, about 30 seconds to 13 minutes, about 30 seconds to 12 minutes, about 30 seconds to 11 minutes, about 30 seconds to 10 minutes, about 30 seconds to 9 minutes, about 30 seconds to 8 minutes, about 30 seconds to 7 minutes, about 30 seconds to 6 minutes, about 30 seconds to 5 minutes, about 30 seconds to 4 minutes, typically 5 to 15 minutes. The treatment time may range up to about 90 minutes, about 80 minutes, about 70 minutes, about 60 minutes, about 50 minutes, about 40 minutes or about 30 minutes. It will be appreciated that the treatment time can be adjusted in order to maintain a dosage by adjusting the rate of fluence delivered to a treatment area. For example, for a total dosage of 20 J/cm^2 and a treatment time of 15 minutes, the fluence can be delivered at any rate of 1.3 J/cm^2 per minute. In certain embodiments, the maximum light intensity can be about 12 J/cm^2 per minute of treatment. The fluence rate can be adjusted to the therapy sought.

In certain embodiments, a fluence emitted by the second light source or delivered to the treatment area from the second light source is lower than a fluence emitted by the first light source or delivered to the treatment area from the first light source. For example, the fluence emitted by the second light source or delivered to the treatment area from the second light source is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment

In some embodiments, the peak wavelength of the first light is from about 440 nm to about 470 nm and has a bandwidth of about 18-24, and the peak wavelength of the second light is from about 410 nm to about 430 nm and has a bandwidth of about 13-18 nm. In those embodiments, the device can emit an average power density of about 55 to about 130 mW/cm^2, or about 10 to about 75 mW/cm^2. In certain embodiments, the fluence rate is about 5-10 J/cm^2 per minute.

In certain embodiments, the second light has a larger bandwidth than the first light, and wherein the second light has a lower average power density than the first light. The second light may have a lower fluence than the first light. The second light may have a maximum power at the second peak wavelength which is lower than a maximum power at the first peak wavelength of the first light.

In certain embodiments, the device further comprises a third light source, wherein the third light source can emit a third light having a peak wavelength of about 500 nm to about 750 nm, about 630 to about 750 nm, or about 750 nm to about 1 mm.

From a further aspect there is provided a device for phototherapy comprising: a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and an average power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

From a yet further aspect there is provided a device for phototherapy comprising: a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 19 nm ± about 5 nm.

From another aspect there is provided a device for phototherapy comprising: a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

From a yet further aspect there is provided a device for phototherapy comprising: a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

From a yet further aspect, there is provided a device for phototherapy having at least one light source arranged to emit light having a bandwidth of more than about 15 nm, having a peak wavelength of between about 400 nm to about 700 nm, and wherein the emitted power density of the light is decreased over a light emission period. The power density may be decreased at any rate, for example at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute. This may substantially simulate a fluorescence emitted by a chromophore and the decay of the power intensity of the fluorescence with time.

In certain embodiments of any of the above aspects, the first light may have an average power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

In certain embodiments of any of the above aspects, the first light may have a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

In certain embodiments of any of the above aspects, the first light may have a bandwidth of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. The first light may have a bandwidth of about 19 nm ± about 5 nm.

In certain embodiments of the aspects above, there is provided a second light source having a peak wavelength which can emit a second light, wherein the second light comprises at least one of the following:

a) a bandwidth which is larger than a bandwidth of the first light,
b) an average power density which is lower than an average power density of the first light,
c) a power at the peak wavelength which is lower than a power at the peak wavelength of the first light,
d) a longer peak wavelength than the peak wavelength of the first light, or
e) a fluence which is lower during a treatment time than a fluence of the first light.

The average power density of the second light may be about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

The fluence emitted by the second light source or delivered to a treatment area from the second light source is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment.

The bandwidth of the second light may be more than 20 nm, about 20-100nm, about 20-80 nm, about 20-60 nm, about 20-40 nm.

The power at a peak wavelength may be about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the power at a peak wavelength of the first light.

The disclosure contemplates that any of the embodiments set forth below can be combined with each other or with any of the aspects or embodiments set forth above, or otherwise set forth herein.

In certain embodiments, the device further comprises a controller in electronic communication with the first and second light sources for varying a first emission spectrum of the first light and/or a second emission spectrum of the second light, wherein the first and second emission spectra include one or more emission spectra parameters selected from a bandwidth, the peak wavelength, a power density, a time of emission and a fluence. The controller may be able to control separately one or more of the emission spectra parameters of each of the first and second lights. In some embodiments, the controller is arranged to modulate one or more of the emission spectra parameters of the first and second lights as a function of treatment time. In some embodiments, the controller may be arranged to modulate one or more of the emission spectra parameters of the first and second lights as a function of treatment time, for example, by diminishing the emitted power density of the first light source during the light emission time, and optionally by increasing the emitted power density of the second light source during the light emission time, to mimic a fluorescence or a phosphorescence emitted by activated chromophores. The controller may include treatment modes with pre-set treatment parameters including emitted light density, wavelength, variation of emitted light density and wavelength with time, and treatment distance. For example, the treatment modes may include different treatment parameters for treating mild acne, severe acne, deep wrinkles, mild wrinkles, and different grades of ulcers. In certain embodiments, the controller can control a pulsing of any of the light sources.

In certain embodiments, the first light source and the second light source (when present), can emit non-coherent light. For example, the first light source and the second light source (when present), can comprise Light Emitting Diodes (LEDs). The LEDs can be arranged as an array. The array may be supported on at least one panel. The LEDs from the first light source may be considered as a set of LEDs, and the LEDs from the second light source (when present) may be considered as another set of LEDs, each set of LEDs comprising at least one LED. The LEDs from each set may be arranged in an interdispersed fashion or in a side-by-side fashion. For example, the second light sources may be interdispersed amongst the first light sources in the array. The first and second light sources (when present), and/or the individual LEDs may be spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another. They may be substantially equally spaced apart.

The array of LEDs may be arranged on at least one panel. The device may comprise a plurality of connectable panels. The panel(s) may present a flat or curved light emitting surface. The connectable panels may be moveable with respect to each other or be in a fixed configuration. The device may comprise a panel controller in electronic communication with the panels to separately control a light emission from the panels.

The device may also include a cooling system which may comprise a heatsink coupled to the array of LEDs, a fan for cooling the array of LEDs, a vent in a housing of the device supporting the light sources for allowing heat to be removed by convection, a heat shield, or by any other means.

The device may also include one or more filters for filtering the first light and/or the second light (when present). The device may further comprise a collimator for collimating the first and/or the second light (when present). The device may further comprising a spacing probe extending from an emitting face of the device to indicate a treatment distance.

In another embodiment, the light source(s) or array of LEDs may be provided on a flexible substrate such as a fabric, for use with a dressing or a mask, or forming part of a dressing or a mask.

The light emitting surface of the device may comprise one or more waveguides such as a fibre optic, or a bundle of fibre optics connectable to the one or more light sources. The fibre optics may be made of any material with suitable light carrying and tensile properties, such as polymethylmethacrylate (PMMA). The fibre optic(s) may be encased in a sleeve. The fibre optics can thus be used to deliver the therapeutic light from the device to an internal cavity of a subject or a hard to reach treatment area on the subject.

In certain embodiments of the above aspects, the light source can emit light within the violet range (400-450 nm), the blue range (450-490 nm), the green range of the electromagnetic spectrum (about 490 to about 560 nm), the yellow range (560-590 nm), the orange range (590-635), or the red range of the electromagnetic spectrum (about 635 to about 750 nm). These emitted wavelengths together with the power density, fluence and/or bandwidths described above, can photoactivate biophotonic compositions, and/or have a therapeutic effect themselves.

In certain embodiments, the peak wavelength emitted by the first light source is about 440-470 nm, has a bandwidth of about 20nm ± 2nm, and a total power density at 5cm of between about 100-150 mW/cm^2, 60-135 mW/cm^2, about 135 mW/cm^2. In another embodiment, the peak wavelength emitted by the first light source is about 440-480 nm, and has a total power density at 5 cm or at 10 cm of less than about 75 mW/cm^2, about 25 to about 70 mW/cm^2, about 30 to about 65 mW/cm^2, about 55 to about 65 mW/cm^2. In another embodiment, the device includes a second light source which can emit light having a peak wavelength of about

410 nm to about 420 nm, a bandwidth of about 13-15 nm and a total power density within the range 0.01 to 5 mW/cm^2.

At least one light source having a wavelength within the violet/blue ranges with a peak of about 440-470 nm has been found to excite yellow/orange/red dyes, such as Eosin Y, Fluorescein, Rose Bengal, Phloxine B, and Erythrosine, each of which, together with the violet/blue light, has been observed by the inventors to have beneficial effects at the treatment area such as modulation of blood flow and collagen modulation.

In certain embodiments, the light emitted from the light source, as well as being an activating light for a chromophore in a photoactivatable composition, may also have therapeutic benefits itself when applied to tissue e.g. antimicrobial properties, modulation of blood flow at the treatment site, collagen modulation, or any other cosmetic or medical therapeutic effects. Therefore, it may be advantageous to use the device with a photoactivatable composition which also allows the activating light to pass therethrough in order to be able to irradiate the tissues onto which the composition is applied. The photoactivatable composition may be substantially transparent or translucent, or otherwise optically conductive.

The first, second and/or third light sources may emit light having different/complementary properties simultaneously, at different times and/or for different time periods, from a single light source or a plurality of light sources. In this way, the device may be used to treat different stages of a condition for example treating an infection on a wound first, followed by a reduction in inflammation, and collagen modulation to minimize scarring during wound healing. Another example is to treat acne by initially killing the bacteria thought to be responsible for the condition (e.g. propionibacterium acnes (*p.acnes*)) on the skin of subject, followed by vascularization and collagen modulation to heal the acne lesions and scars.

The device of any of the above embodiments may be a head for a lamp, or the lamp itself. When the device is a head, it may be interchangeable with other lamp heads and configured to fit on the same lamp base structure. The light sources on different heads may be configured to emit different parameters, such as wavelength, pulse duration, total emitted energy, or the different heads may have different sizes and shapes suitable for treatment of different body parts.

From a yet further aspect, there is provided a lamp, comprising a lamp head having a plurality of light emitting diodes (LEDs) arranged in an array, the array comprising at least two sets of LEDs, wherein each set includes at least one LED; a lamp controller electrically connected to the lamp head and having circuitry for controlling and operating the LEDs; wherein the first set of LEDs can generate non-coherent light having a peak wavelength of about 430 nm to about 500 nm; wherein the second set of LEDs can generate non-coherent light having a peak wavelength of about 400 nm to about 430 nm; and wherein a power density of light which can be generated by the lamp head is from about 10 to about 75 mW/cm^2, or from about 55 mW/cm^2 to about 150 mW/cm^2.

From a yet further aspect, there is provided a lamp head having a plurality of light emitting diodes (LEDs) arranged in an array, the array comprising at least a first set and a second set of LEDs, wherein each of the first and second sets include at least one LED; a lamp controller electrically connected to the lamp head and having circuitry for controlling and operating the LEDs; wherein the first set of LEDs can generate a first non-coherent light having a peak wavelength of about 430 nm to about 500 nm; wherein the second set of LEDs can generate a second non-coherent light having a peak wavelength of about 400 nm to about 430 nm; wherein a power density of light which can be generated by the lamp head or which can be received by a treatment surface is from about 4 to about 75 mW/cm^2, or from about 55 mW/cm^2 to about 150 mW/cm^2.

From another aspect, there is provided a lamp, comprising a lamp head having a plurality of light emitting diodes (LEDs) arranged in an array, the array comprising at least a first set and a second set of LEDs, wherein each of the first and second sets include at least one LED; a lamp controller electrically connected to the lamp head and having circuitry for controlling and operating the LEDs; wherein the first set of LEDs can generate non-coherent light having a peak wavelength of about 400 nm to about 500 nm; wherein the second set of LEDs can generate non-coherent light having a peak wavelength of about 500 to about 760 nm; wherein a power density of light which can be generated by the lamp head is from about 4 to about 75 mW/cm^2, or from about 55 to about 150 mW/cm^2.

The first set of LEDs can generate light having a bandwidth of about 19 nm ± 5 nm, or about 13 to about 26 nm. The second set of LEDs can generate light having a bandwidth of about 13 nm to about 20 nm. The lamp may further comprise a third set of LEDs, wherein the third set of LEDs can generate non-coherent light having a peak wavelength of about 500 nm to 750 nm, or about 630 to about 720 nm.

The lamp may further comprise a controller arranged to vary one or more parameters of the first and/or the second light, the one or more parameters being selected from power density, bandwidth, wavelength, fluence and emission time.

In certain embodiments, the first and second set of LEDs are spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another in the array. The LEDs of the first and second sets of LEDs may be interdispersed amongst each other. The LEDs of the first and second sets of LEDs may be substantially equally spaced apart in the array. The lamp head may comprise a plurality of panels housing the LEDs, said panels being moveable with respect to each other. Preferably, the lamp controller can control the LEDs of each of the panels separately.

The lamp may further comprise one or more filters for filtering the first and/or second light. The lamp may also further comprise a collimator for collimating the first and/or second lights. The lamp may also include a spacing probe extending from an emitting face of the lamp to indicate a treatment distance. At least one vent may be included in the lamp head for cooling. Other cooling systems are also possible.

The lamp may be arranged to emit or to deliver to a treatment surface a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2. The lamp may also be arranged to emit or deliver a power density from about 10 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, about 110 to about 135 mW/cm^2, about 10 to about 85 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

In some embodiments, the device or the lamp is portable. It may be provided with wheels or handle(s). The device or lamp may include a mount for mounting the lamp to furniture, such as a bed, or to a wall. The device or lamp may also include a support to support the device or lamp on a floor such as legs, feet, wheels, or base. The support may include a weighted base or a long foot which can slide under furniture and prevent the device or lamp from falling over. The mount or the support may be foldable for ease of storage and portability. A portable version of the device or the lamp may be battery operated or rechargeable, and may be provided with or without a cable. A power supply such as a battery may be included within a charging base to which the lamp can be attached, or within a body of the lamp.

In one embodiment of a portable hand-held lamp, the lamp head has a circular emitting surface of a diameter of, for example, about 5 cm to about 10cm. In this case, in order to treat a larger diameter treatment area than the beam diameter, LEDs with a broad divergence angle are used, and the portable lamp is held at a sufficient distance from the treatment area in order to provide light over a larger diameter than the diameter of the emitting surface. In one embodiment, the light density is about 75 to about 120 mW/cm^2. The wavelength is about 420-490 nm with a peak around 460-470 nm.

From another aspect, there is provided a device having at least one light source which can emit light substantially corresponding to a fluorescence or a phosphorescence emitted by an activated chromophore. In one embodiment, the light source is arranged to emit light having a bandwidth of more than about 15 nm, more than about 20 nm, more than about 25 nm, more than about 30 nm. The bandwidth may be for example about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. In certain embodiments, the device is arranged to modulate the emitted light source over a period of light emission from the device, for example a decrease in emitted power density over time. In certain embodiments, the at least one light source is arranged to emit light having a peak wavelength of between about 400 nm to about 750 nm, about 480 nm to about 700 nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm. In one embodiment, the light source can generate light with a total power density of between 0.005 to about 10 mW/cm^2, about 0.01 to 0.1 mW/cm^2, about 0.01 to about 2 mW/cm^2, about 0.01 to about 3 mW/cm^2, about 0.5 to about 5 mW/cm^2.

The power density may be decreased at any rate, for example at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute.

From another aspect, there is provided use of a device or a lamp as defined above with a photoactivatable composition. In certain embodiments, the photoactivatable composition includes a photoactive agent. The photoactive agent may be a fluorescent agent such as a dye. The photoactive agent may absorb or emit light in at least one of the green, yellow, orange or red portions of the electromagnetic spectrum. In one implementation, the photoactive agent is within an optical medium which can be applied to the tissue or placed near the tissue and has a usual peak excitation wavelength (in water or alcohol) in the range of about 400 to about 700 nm, about 420-565 nm, about 420-540 nm, about 470-535nm, or about 450 nm to about 700 nm. In certain embodiments, the photoactivatable composition comprises any one or more of Eosin Y, Fluorescein, Rose Bengal, Erythrosine, Phloxine B, chlorophyll a, chlorophyll b, chlorophyllin.

From a further aspect, there is provided use of a device or a lamp as described above for cosmetic use or cosmetic treatment of a tissue (e.g. skin rejuvenation, skin conditioning, skin maintenance, reducing or eliminating scarring, removing tattoos, evening skin tone, reducing pore size, increasing tissue luminosity, reducing or diminishing scarring), medical use (e.g. wound healing), use in treating inflammation, use in treating bacterial, viral or fungal infections, use in treating skin conditions such acne, rosacea, psoriasis, eczema, dermatitis and/or diagnostic use. The device and/or lamp may be used in any setting including at home, hospital, clinic, field etc..

In certain embodiments of the uses above, the device can be a mobile device such as a hand-held computing device, a smart phone, or a mobile telephone with a display screen, a camera flash or a flashlight as the emitting surface, e.g. iphone®, ipad®, Samsung galaxy®. In these embodiments, 'applications' which emit light having emission spectra which can activate a photoactivatable composition, as described herein, can be used and are included within the scope of the present application. In the same way, a display screen of a desktop computer or a television can be adapted to emit light having emission spectra which can activate a photoactivatable composition. In this way, a user may benefit from a therapeutic effect of light and a photoactivatable composition simply by positioning the area of treatment near a light emitting surface of the mobile device or display screen. The television, computer monitor or mobile device may have a light source which can photoactivate a photoactivatable composition in about 15 minutes, 30 minutes, 45 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7 hours or 8 hours of irradiation, and/or which can emit light having an emission spectra which overlaps an absorption spectra of a photoactive agent in the photoactivatable composition.

The devices and lamps of the present disclosure may be embodied in objects such as a a mobile device, television, computer, bath, a shower, a bed, a tanning bed, items of clothing, blankets, covers etc.

From a yet further aspect, there is provided a cosmetic method or a medical method for treating tissues, said method comprising: irradiating a treatment area with light having an emission spectra as defined above (in relation to the light emitted by the devices and lamps of the present disclosure). For example, the treatment area may be irradiated with two lights which have different emission spectra within the blue and/or violet regions of the electromagnetic spectrum.

From another aspect, there is provided a method for cosmetic or medical treatment of tissue, said method comprising: irradiating a photoactivatable composition applied on or near a treatment area on the tissue or the treatment area on the tissue with a first light having a first peak wavelength which can activate the photoactivatable composition ; and irradiating the same or a different photoactivatable composition or the treatment area on the tissue said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first and the second peak wavelengths are in the blue and/or violet regions of the electromagnetic spectrum.

From another aspect, there is provided a method for cosmetic or medical treatment of tissue, said method comprising: irradiating said tissue with a first light having a first peak wavelength; and irradiating said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first peak wavelength is in the blue and/or violet regions of the electromagnetic spectrum.

From another aspect, there is provided a method for cosmetic or medical treatment of tissue, said method comprising: irradiating the tissue with non-coherent light from a first light source having a peak wavelength of about 430 nm to about 500 nm; irradiating the tissue with non-coherent light from a second light source having a peak wavelength of about 400 nm to about 430 nm; wherein the tissue is irradiated with a total power density of light of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

In certain embodiments, the method further comprises applying a photoactivatable composition on or near the treatment area on the tissue before irradiating the tissue.

The first peak wavelength may be about 430 to about 500 nm, about 440 to about 500 nm, about 450 to about 500 nm, about 430 to about 475 nm, about 440 nm to about 460 nm, about 445 nm to about 455 nm, about 435 nm to about 470 nm, about 440 nm, about 450 nm, about 460 nm or about 470 nm. The second light may have a peak wavelength of about 400 nm to about 500 nm, about 400 nm to about 475 nm, about 400 nm to about 450 nm, about 400 nm to about 430 nm, or about 410 nm to about 420 nm, about 415 nm. For example, the first peak wavelength may be from about 410 nm to about 430 nm, and the second peak wavelength may be from about 440 nm to about 470 nm.

Alternatively, the second peak wavelength may be about 480 to about 760 nm, about 480 nm to about 700 nm, about 480 nm to about 650 nm, about 480 nm to about 620 nm, about 500 to about 700 nm, about 520 nm to about 700nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm, about 540 nm to about 580 nm, about 500 nm to about 570 nm, about 570 nm to about 590 nm, about 590 nm to about 610 nm, about 610 nm to about 760 nm, or within the infrared range of the electromagnetic spectrum.

In certain embodiments, at least one of the first and second lights has a bandwidth of equal to or less than about 20 nm or about 19 nm ± 5 nm. The second light may have a bandwidth of between about 15 nm and about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. The second light may have a bandwidth which is broader than a bandwidth of the first light. For example, the bandwidth of the first light may be about 15 nm to about 25 nm and the bandwidth of the second light may be about 20 nm to about 100 nm.

An average power density emitted by the first and second lights and/or received by the treatment area can be about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 200 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about

55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, or about 110 to about 135 mW/cm^2.

An average power density emitted by the first and second lights and/or received by the treatment area may be about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 85 mW/cm^2, about 10 to about 75 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 mW/cm^2 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

In certain embodiments, an average power density of the second light is lower than an average power density of the first light. The average power density of the second light may be about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

A fluence of the light received by a treatment area, during a single treatment, may be more than about 4 J/cm^2, more than about 10 J/cm^2, more than about 15 J/cm^2, more than about 30 J/cm^2, more than about 50 J/cm^2, up to about 60 J/cm^2. A fluence of the light received by a treatment area, during a single treatment, may be about 4 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 50 J/cm^2, about 10 J/cm^2 to about 40 J/cm^2, about 10 J/cm^2 to about 30 J/cm^2, about 20 J/cm^2 to about 40 J/cm^2, about 15 J/cm^2 to about 25 J/cm^2, or about 10 J/cm^2 to about 20 J/cm^2.

In certain embodiments, a single treatment comprises irradiating the tissue or the photoactivatable composition for up to about 90 minutes, 80 minutes, 70 minutes, 60 minutes, 50 minutes, 40 minutes, 30 minutes, for about 1 to about 30 minutes, for about 1 to about 25 minutes, for about 1 to about 20 minutes, for about 1 to about 19 minutes, for about 1 to about 18 minutes, for about 1 to about 17 minutes, for about 1 to about 16 minutes, for about 1 to about 15 minutes, for about 1 to about 14 minutes, for about 1 to about 13 minutes, for about 1 to about 12 minutes, for about 1 to about 11 minutes, for about 1 to about 10 minutes, for about 1 to about 9 minutes, for about 1 to about 8 minutes, for about 1 to about 7 minutes, for about 1 to about 6 minutes, for about 1 to about 5 minutes, for about 1 to about 4 minutes, or for about 1 to about 3 minutes. The light may be applied continuously or pulsed.

In certain embodiments, a fluence delivered to the treatment area from the second light source is lower than a fluence emitted by the first light source or delivered to the treatment area from the first light source. The fluence delivered to the treatment area from the second light source may be about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment.

In certain embodiments, the second light may have a larger bandwidth than the first light, and wherein the second light has a lower average power density than the first light. The second light may have a lower fluence than the first light.

In certain embodiments, the second light has a maximum power at the peak wavelength which is lower than a maximum power at the peak wavelength of the first light.

The method may further comprise varying an emission spectra of the first and/or second lights during a treatment time, wherein the emission spectra of each of the first and second lights include one or more emission spectra parameters selected from a bandwidth, a peak wavelength, a power density, a time of emission and a fluence.

From another aspect, a method for cosmetic or medical treatment of a tissue comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

From another aspect, a method for cosmetic or medical treatment of a tissue comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 19 nm ± about 5 nm.

From another aspect, a method for cosmetic or medical treatment of a tissue comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

From another aspect, a method for cosmetic or medical treatment of a tissue comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and modulating at least one of the peak wavelength, bandwidth, power density or fluence of the first light during the irradiation of the tissue.

From another aspect, a method for cosmetic or medical treatment of a tissue comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2

The method may comprise irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and modulating at least one of the peak wavelength, bandwidth, power density or fluence of the first light during the irradiation of the tissue. In one implementation, the method comprises decreasing or increasing the maximum power intensity of the light emitted from at least one light source during the time of light irradiation. Lights from different light sources may be modulated differently, at different times or at the same time. It will be understood that that the modulation of light from one light source may occur over only a portion of the total irradiation time, or over the full irradiation time. In certain embodiments, the power density may be increased or decreased at a rate, for example, of at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute.

The treatment area may be irradiated simultaneously or at different times, from a single light source or a plurality of light sources with light having different properties. The irradiating light may have any of the properties described above in relation to aspects of the device and lamp.

In certain embodiments, the irradiating light is a fluorescence or phosphorescence light within one or more of the green, yellow, orange, red and infrared portions of the electromagnetic spectrum, for example having a peak wavelength within the range of about 490 nm to about 720 nm. In one embodiment, the irradiating light has a wavelength of between about 400 nm to about 700 nm, about 480 nm to about 700 nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm. In another embodiment, the irradiating light has a power density of between 0.005 to about 10 mW/cm^2, about 0.5 to about 5 mW/cm^2. In certain embodiments, the irradiating light has a bandwidth of about 15 nm to about 100nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. The light source of the irradiating light may be a photoactive agent such as a fluorochrome which is activated by the first light source, or any other light source, to emit fluorescence. Alternatively, the irradiating light may be from an electronically generated light such as LED, laser etc which mimics a fluorescence or phosphorescence spectra.

In certain embodiments, the average or total power density of the irradiating light is from about 0.01 mW/cm^2 to about 200 mW/cm^2, 0.02 mW/cm^2 to about 150 mW/cm^2, 0.02 mW/cm^2 to about 135 mW/cm^2, 0.02 mW/cm^2 to about 75 mW/cm^2, 0.02 mW/cm^2 to about 60 mW/cm^2, about 0.02 mW/cm^2 to about 50 mW/cm^2, about 0.02 mW/cm^2 to about 30 mW/cm^2, about 0.02 mW/cm^2 to about 15 mW/cm^2.

It will be clear to a skilled person that combinations of the embodiments of the irradiating light described above are also possible. For example, irradiating the treatment area with light having different emission spectra for the same or different times. In one embodiment, the treatment area is irradiated with light from a first light source having a peak wavelength of about 440-470 nm, a bandwidth of about 20nm $\pm$ 2 nm, and a total or average power density between about 60-150 mW/cm^2; and light from a second source having a peak wavelength of about 540 nm to about 640 nm, a power density of between 0.005 to about 10 mW/cm^2, about 0.5 to about 5 mW/cm^2, and a bandwidth of about 20 nm to about 100nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

From another aspect, there is provided a system for treating tissues, said system comprising: at least one light source for irradiating a treatment area, the at least one light source being able to emit irradiating light having an emission spectra which can have one or more of the following properties: (i) produce an antimicrobial effect on a treatment area irradiated with the emitted light, (ii) modulate blood flow in the treatment area, and/or (iii) activate a photoactivatable composition comprising a chromophore which may then emit a light with therapeutic properties or which can release bio-therapeutic reactive species onto, into or nearby the treatment area such that a photoactive agent in the photoactivatable composition is not internalized by the cells and/or does not sensitize the cells. The treatment area may be irradiated simultaneously or at different times, from a single light source or a plurality of light sources, with the light having the different properties. The irradiating light may have any of the properties described above in relation to aspects of the device, lamp and/or system.

From another aspect, there is provided a system for treating tissues, said system comprising: a lamp or a device, as described above, and a photoactivatable composition including a photoactive agent.

In certain embodiments, the emitted light from the at least one light source has a peak wavelength of about 400 nm to about 720 nm, 400 nm to about 550 nm, about 450 nm to about 500 nm, about 440 to about 475 nm, about 450, about 446, about 464 nm or about 470 nm. The light source in this case can be at least one LED or any array of LEDs.

In certain embodiments, the irradiating light is fluorescence or phosphorescence light within one or more of the green, yellow, orange, red and infrared portions of the electromagnetic spectrum, for example having a peak wavelength within the range of about 520 nm to about 720 nm. In this case, the system includes a photoactive agent as a light source. In one embodiment, the irradiating light has a wavelength of between about 400 nm to about 700 nm, about 480 nm to about 700 nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm. In another embodiment, the irradiating light has a power density of between 0.005 to about 10 mW/cm^2, about 0.5 to about 5 mW/cm^2. In certain embodiments, the irradiating light has a bandwidth of about 20 nm to about 100nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. The light source of the irradiating light may be a photoactive agent such as a fluorochrome which is activated by the first light source, or any other light source, to emit fluorescence. Alternatively, the light source may be from an array of LEDs which substantially mimics a fluorescence or phosphorescence spectra.

In certain embodiments, the light source can generate light having a peak wavelength of about 400 nm to about 500 nm, optionally about 400 nm to about 475 nm, optionally about 400 nm to about 450 nm, optionally about 410 nm to about 420 nm, or in a certain embodiment about 415 nm to about 418 nm. The light source in this case can be at least one LED or any array of LEDs.

It will be clear to a skilled person that combinations of one or more of the embodiments of the light sources described above are also possible within the system of the disclosure. For example, the system may comprise a first light source having a peak wavelength of about 450 nm, a bandwidth of about 20nm or less, and an average or total power density between about 130-150 mW/cm^2; and a second source which is a photoactivatable composition which can emit fluorescence or phosphorescence. In one embodiment, the fluorescence has a peak wavelength of about 540 nm to about 640 nm, a power density of between 0.005 to about 10 mW/cm^2, about 0.5 to about 5 mW/cm^2, and a bandwidth of about 20 nm to about 100nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

In certain embodiments, the system comprises a controller for modulating the irradiating light during the treatment period, for example, by modulating the emitted the average or maximum power density of the irradiating light over a treatment time or by modulating a bandwidth or wavelength range. In one implementation, the method comprises decreasing or increasing the maximum power intensity or the average power of the light emitted from at least one light source during the time of light irradiation. Lights from different light sources may be modulated differently, at different times or at the same time. The power density of any of the emitted lights may be decreased at any rate, for example at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute. It will be understood that that the power density modulation may occur over only a portion of the total irradiation time, or over the full irradiation time.

From another aspect, there is provided a cosmetic or a medical method of treating tissue, said method comprising irradiating a treatment site of a tissue with a first light which decreases in power density during at least a portion of the total irradiation time. Optionally, the method can comprise irradiating the same treatment site of the tissue with a second light which increases, stays the same or decreases in power intensity during at least a portion of the total irradiation time. In one embodiment, the first light has a multi-colour bandwidth and comprises one or more of a green, yellow, orange or red light. In one embodiment, the second light has a wavelength range within a single colour and comprises a blue or violet light. In certain embodiments, the wavelength and/or bandwidth of the first light and/or second light also changes during at least a portion of the total irradiation time. In other embodiments, the first light is generated by at least one fluorochrome in a composition on or near the treatment site. The method may further comprise further step(s) of modulating the power density of the first light or the second light by varying a thickness of the composition, by varying the distance of a light source from the treatment site, by varying a concentration of the fluorochrome in the composition, or by adding chemical species to the fluorochrome to enhance fluorescence such as halides.

From a yet further aspect, there is provided a system for treating tissues, said system comprising a first light source which can generate a first light which can decrease in power density during at least a portion of the total irradiation time. Optionally, the system comprises a second light source which can generate a second light which increases, stays the same or decreases in power intensity during at least a portion of the total irradiation time. In one embodiment, the first light has a multi-colour bandwidth and comprises one or more of a green, yellow, orange or red light. In one embodiment, the second light has a wavelength range within one colour and comprises a blue or violet light. In certain embodiments, the wavelength and/or bandwidth of the first light and/or second light also changes during at least a portion of the total irradiation time. In other embodiments, the first light source comprises at least one fluorochrome in a composition on or near the treatment site.

Without being bound to theory, the individual and combined wavelengths, bandwidths, emitted power densities and intensities described above are thought to have certain complementary therapeutic effects on tissues which they irradiate. The inventors have observed that light with a peak wavelength of about 410-490 nm has blood flow modulation properties at the treatment site and may have anti-inflammatory and collagen modulation properties. It has also been discovered by the inventors that blue light with a peak wavelength of about 410-490 nm and a bandwidth of about 15-25 nm can photoactivate green, yellow and orange dyes in an optical medium on or near the tissues causing them to fluoresce. According to Stokes' shift the emitted fluorescent light has a longer peak wavelength than the activating light, the longer wavelengths having deeper tissue penetration. The emitted fluorescent light can be multi-colour bandwidth which is thought to enhance its potentially therapeutic effect. Therefore, it is believed that the emitted fluorescent light also has a therapeutic effect on tissues which it irradiates, and which is complementary to the therapeutic effect of the light emitted from the light source. In the presence of oxygen, the photoactivation may also generate reactive oxygen species at levels having a therapeutic effect.

Definitions

As used in this specification and the appended claims, the singular form "a", "an" and "the" include plural referents unless the context clearly dictates otherwise.

As used herein, the term "about" in the context of a given value or range refers to a value or range that is within 20%, preferably within 10%, and more preferably within 5% of the given value or range.

It is convenient to point out here that "and/or" where used herein is to be taken as specific disclosure of each of the two specified features or components with or without the other. For example "A and/or B" is to be taken as specific disclosure of each of (i) A, (ii) B and (iii) A and B, just as if each is set out individually herein.

By "antimicrobial effect" is meant that microorganisms such as bacteria, fungi and protozoans can be killed or inhibited. It can include a bactericidal effect or a bacteriostatic effect.

By "emission spectra" is meant the spectrum of frequencies of electromagnetic radiation defining the properties of the emitted light, usually in terms of wavelength, power density, and bandwidth.

By "light emitting diode" is meant any light emitting diode including organic, polymer, solid-state and RGB.

By "light source" is meant any source of light which can output light having the desired characteristics, such as light emitting diodes; incandescent light bulbs; electron stimulated; electroluminescent materials such as electroluminescent wires and sheets, field-induced polymer electroluminescent materials; gas discharge bulbs such as fluorescent lamps, cathode lamps, neon and argon lamps, plasma lamps, xenon flash lamps; high intensity discharge lamps such as metal-halide lamps, diode lasers, fiber lasers, arc discharge or other light sources. The light source can emit a pulsed or continuous light wave which may be spectrally concentrated or spectrally diffuse (i.e., broadband). A photoactive agent or agents which can emit light is also considered a light source herein. A light source can be understood to also include a set of one or more light generating units having similar properties e.g. similar wavelengths.

By an emission spectra having a "peak" is meant that the emission spectrum of the light is a narrow bandwidth spectrum or a quasi-monochromatic spectrum.

By "peak wavelength" is meant the wavelength(s) at which the light has a maximum power or intensity, and usually measured in nm.

By "power", "intensity", "power density", "average power" is meant the irradiance of the light which is defined as the radiant power per unit of surface, and is usually measured in W/cm^2 or mW/cm^2. The radiant power is the power per unit of time and is measured in Watts (W).

By "maximum power at peak wavelength" is meant the maximum power value(s) at the peak wavelength of the light, and is usually measured in $mW/cm^2/nm$.

By "total power of a peak", "total power" or "average power density" of a light is meant the power of a peak at all wavelengths of that peak, usually measured in mW/cm^2.

By "bandwidth" is meant the spectral bandwidth at half the maximum intensity, or FWHM (full width at half maximum).

By “fluence” is meant the radiant power per unit area (also known as “power” or “intensity” or “power density”) multiplied by the time. Fluence is usually measured in J/cm^2. The fluence is also known as the dosage.

By “photoactivatable composition” is meant any medium including a chromophore in which the molecules of the chromophore are able to absorb radiant energy within the medium leading to the emission of absorbed light, for example as fluorescence, or transition of the chromophore molecules to an excited state and subsequent interaction with other molecules. The excited state is referred to herein, interchangeably, as ‘photoexcited’ or ‘photoactivated’.

Terms “chromophore”, “photoactivating agent”, “photoactive agent” and “photoactivator” are used herein interchangeably. A chromophore means a chemical molecule or compound, when contacted by light irradiation, is capable of absorbing the light.

Further areas of applicability of the disclosed devices, lamps, uses and methods will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating particular embodiments, are intended for purposes of illustration only and are not intended to limit the scope of the disclosure or any claims that may be pursued.

BRIEF DESCRIPTION OF THE FIGURES

The foregoing and other objects and advantages will be appreciated more fully from the following further description thereof, with reference to the accompanying drawings. These depicted embodiments are to be understood as illustrative and not as limiting in any way.

FIG. 1 shows a schematic view of a device for emitting light comprising first and second light sources, according to certain embodiments of the present disclosure.

FIG. 2 shows an exemplary physical arrangement of the array of light generating sources of the device of FIG. 1, according to certain embodiments of the present disclosure.

FIG. 3 is a spectrum of the light emitted by the device of FIG.1, according to certain embodiments of the present disclosure, when measured at 5cm from the light source.

FIGS. 4a to 4d shows alternative exemplary physical arrangements of arrays of light generating sources (**FIG.4a - FIG. 4d**) according to certain embodiments of the present disclosure.

FIG. 5 is a spectrum of the light emitted by another implementation of the device of FIG.1, according to certain embodiments of the present disclosure, when measured at 5cm from the light source.

FIG. 6 shows an exemplary block diagram of a computing device for performing any functions according to certain embodiments of the present disclosure.

FIG. 7a is an emission spectrum showing the power intensity over time of a light treatment applied to cells to assess angiogenesis, according to embodiments of the present dislcosure (Example 1); and **FIG.7b** is an enlarged portion of the emission spectrum of **FIG. 7a**.

FIG. 8 illustrates the decrease in average power density over emission time and at different distances from the light source of a fluorescent light emitted by a photoactivated composition by a device or a system according to certain embodiments of the present disclosure (Example 3).

FIG. 9 illustrates the increase in average power density over emission time and at different distances from the light source of light transmitted through a photoactivatable composition by a device or a system according to certain embodiments of the present disclosure (Example 3).

FIG. 10a is an emission spectrum showing the power intensity over time of one of the light treatments applied to cells to assess collagen formation, according to embodiments of the present disclosure (Example 3); and **FIG. 10b** is an enlarged portion of the emission spectrum of **FIG. 10a**.

FIG. 11a is a graph showing the effect on bacterial growth of light from a device according to certain embodiments of the present disclosure (Example 4).

FIG. 11b is a graph showing the effect on bacterial growth of light from a device according to certain embodiments of the present disclosure (Example 4).

DETAILED DESCRIPTION

To provide an understanding of the devices, lamps, systems and methods described herein, certain illustrative embodiments will now be described. For the purpose of clarity and illustration, the embodiments are described primarily with respect to light emitting diode (LED) light sources. However, it will be understood by one of ordinary skill in the art that other light sources may also be used in the devices, lamps, systems and methods described herein, which may be adapted and modified as appropriate. Such other additions and modifications will not depart from the scope hereof.

According to a first broad aspect of the present disclosure, there is provided a device 100 for emitting light, the device 100 is a lamp comprising: a first light source and a second light source. Specifically, the first light source, which in one embodiment is a set of first LEDs 102, has an emission spectra which can induce a therapeutic effect on a treatment site or area irradiated with the light source. The therapeutic effect can include an antimicrobial effect and/or a stimulatory effect such as initially increasing blood flow at the treatment site, followed by a reduction in inflammation and collagen production. The second light source, which in one embodiment is a set of second LEDs 104, has an emission spectra which can activate a photoactivatable composition applied on or located near the treatment site, or which may have an effect on local blood flow modulation or collagen remodeling.

The photoactivatable composition generally includes a photoactive agent which when activated can provide a therapeutic effect on the treatment area either by emission of fluorescent light at therapeutic wavelengths and at therapeutic intensities, by emission of energy which can then activate further photoactive agents in the compositions or the treatment site to have a therapeutic effect, and/or by excitation of its molecules to an excited singlet state which can then react with other molecules to produce for example reactive oxygen species. It is believed that low levels of reactive oxygen species can have a therapeutic effect on tissues. Examples of photoactivatable compositions are described in U.S. Patent Application Publication No. 2007/0128132, filed on Nov. 9, 2006, PCT Publication No. WO/2010/051636, filed on Nov. 6, 2009, PCT Publication No. WO/2010/051641, filed on Nov. 6, 2009, and PCT Application No. PCT/CA/2010/001134, filed on Jul. 19, 2010, the contents of which are herein incorporated by reference.

Alternatively, both the light sources can emit light having an emission spectra suitable for activating a photoactivatable composition including one or more photoactive agents. In this way, a broad bandwidth activating energy can be provided to a photoactive agent which can more efficiently photoactivate the photoactivate agent. In the case where there is more than one photoactive agent having different absorption profiles, providing at least two light sources can photoactivate both these agents. Furthermore, some photoactive agents include can have a plurality of peak wavelengths in their absorption spectra. Therefore, the provision of two or more light sources can fully activate the photoactive agent across its entire absorption spectrum in order to benefit from its photoactivated properties.

The first and second sets of LEDs 102, 104 can provide a complementary phototherapeutic treatment to the treatment site, whereby the therapeutic effect of the first set of LEDs 102 is augmented and complemented by the therapeutic effect of the second set of LEDs 104 through, for example, activation of a photoactivatable and therapeutic composition. In some embodiments, a fluorescence emitted by such a photoactivatable composition has a power density at the skin surface of less than about 75 mW/cm^2, less than about 50 mW/cm^2, less than about 10 mW/cm^2, less than about 5 mW/cm^2, less than about 2.5 mW/cm^2, or less than about 2 mW/cm^2. The maximum power density can be from about 0.02 mW/cm^2 to about 75 mW/cm^2, from about 0.02 mW/cm^2 to about 50 mW/cm^2, from about 0.02 mW/cm^2 to about 10 mW/cm^2, from about 0.02 mW/cm^2 to about 5 mW/cm^2, or from about 0.02 mW/cm^2 to about 10 mW/cm^2.

Referring now to an embodiment of the device 100 illustrated in **FIG. 1**, where the first and second set of LEDs 102, 104 are housed in a head 106 of the device which is adjustably attached to a body 108 having a base 110. Locking mechanism(s) can be provided for locking the position of the head, base or body. The LEDs are mounted on a panel (not shown) within the housing as an array and emit light from an emitting surface 112 of the head 106. The device 100 may include lockable wheels at the base (not shown) such that a user may freely move the device to a desired location and lock the device's position.

Optionally, depending on the power of the LEDs used and the treatment time, in order to minimize heating, the head 100 may include one or more cooling systems (not shown) for cooling the first and/or the second set of LEDs such as heat sinks, one or more fans (not shown), vents in the lamp housing, liquid cooling device, and the like. The cooling system may also comprise a shield for absorbing heat.

The device also includes a controller 114 in electronic communication with the LEDs for controlling various parameters of the emitted light such as power on/power off to individual LEDs within a set as well as to the different LED sets. Other parameters which may be controlled by the controller are: the maximum emitted power density of light from each LED, the bandwidth, the peak wavelength of emission, duration of light emission, variation of emitted light power density as a function of light emission time, variation of wavelength as a function of light emission time. This can allow a device operator to tailor the phototherapeutic treatment of each subject according to the therapy required.

The head 106 may be removable from the rest of the device 100 and replaceable. In certain embodiments, the lamp includes rotation device(s) (not shown) that allows for the head 106 to face any direction at any angle for convenience, and to be locked in that position. In certain embodiments, the lamp head (106) may be removable from the rest of the device in order to be used as a portable hand-held lamp. In this case, the lamp head may include one or more components of the controller and optionally a power source. In certain embodiments, there is provided a spacing probe (not shown) extending on the lamp head 106 for spacing the emitting face 112 from the treatment site. This can ensure the delivery of the appropriate light dose which is a function of distance. The spacing probe may be a measuring device such a ruler having an appropriate length, or may comprise a sensor system for detecting the distance using sound or light.

In certain embodiments, there is also provided a work surface, such as a tray, a basket or a net, removably attached to the body of the device 108.

An exemplary physical spatial arrangement of the array of the first and second sets of LEDs 102, 104 are illustrated in **FIG. 2**. The array comprises 40 LEDs arranged in 8 rows and 5 columns with 6 LEDs in the first set and 34 LEDs in the second set. It will be understood by a skilled person that any other number of LEDs with any other array configuration is also possible. In another embodiment, the LED array comprises a total of at least 36 LEDs, at least 40 LEDS, at least 46 LEDs or at least 184 LEDs, mounted on the panel. In one embodiment, the LED array comprises 184 LEDs arranged as 8 rows and 23 columns. In yet another embodiment, the LED array comprises 36 LEDs comprising 6 rows by 6 columns. It will be appreciated by the skilled man that the LED array can be arranged in any configuration and can be any size or shape such as rectangular, circular or any other shape. The panel surface may be graduated so that some of the LEDs are closer to the treatment site than others. For example, may be a rectangular panel comprising the second set of LEDs on a first surface, and the first set of LEDs being mounted around the periphery of the first surface and spaced from the first surface.

In the embodiment of FIG. 2, the first and second sets of LEDs have a different peak emitted wavelength from one another. The first set of LEDs has a peak wavelength of about 410 nm to about 420 nm and a bandwidth of about 13-15nm, which may have an antibacterial effect against certain bacteria such as *p.acnes*, and the second set of LEDs has a peak wavelength of about 440 nm to about 470 nm and a bandwidth of about 20 nm ± 2nm. **FIG. 3** is an exemplary emission spectra of this embodiment of the device measured at 5cm, as measured using a SP-100 spectroradiometer (SP-100, ORB Optronix) to measure the power density spectra versus wavelength Typically, the total emitted power density obtained at a distance of 5 cm with this embodiment of the device is about 60 to 150 mW/cm^2 with a total energy emitted over 5 minutes of about 20 to 50 J/cm^2.

In a different embodiment (not shown), the LEDs are mounted on a flexible substrate which may form part of, or be included with, a dressing, a mask, or any other material which can be applied to skin, hair, nails or other tissues.

The device head 106 may comprise a plurality of connectable panels (not shown) having LEDs mounted thereon. There may be any number of panels connectable together, such as 2, 3, 4, 5, 6 or 7. The panels can be connected together such that their emitting surfaces 112 are angled with respect to one another. In this way, it may be possible to radiate light to different sides of a curved or irregular treatment site of a subject such as face, arms, or legs. The size and shape of the panel will depend on the area to be treated. For example, for treatment of the face, a single curved panel, or a number of joined panels with a curvature can be used. The panels can be moveably connected to one another. A locking mechanism may be provided for fixing the panels in a desired position.

The LED array may also include a third set of LEDs that emits light at a different peak wavelength or power density or bandwidth than the first and/or second set of LEDs. In some embodiments, the third set of LEDs emits light in the red portion of the visible electromagnetic spectrum (e.g., between 630 nm and 700 nm). In other embodiments, the third set of LEDs emits light in the orange portion of the visible electromagnetic spectrum (e.g., between 635 nm and 590 nm). In yet other embodiments, the third set of LEDs emits light in a yellow portion of the visible electromagnetic spectrum (e.g., between 590 nm and 560 nm). In other embodiments, the third set of light generating sources emits light in the infrared portion of the electromagnetic spectrum (e.g., between 800 nm and 1000 nm). Alternative embodiments include LEDs that emit light of different wavelengths and power intensities than those described above, and which have different therapeutic effects.

Further exemplary arrays of the first and second sets of LEDs 102, 104 are illustrated in **FIGS. 4a to 4d**. The LEDs of the second set of LEDs are interdispersed amongst the LEDs of the first set of LEDs. Different numbers and ratios of the number of LEDs in each of the first and second set of LEDs are possible. As the power density which can be emitted by different LEDS can vary, the ratio can also be defined in terms of a power density ratio of the first and second set of LEDs. The number or the power density ratio can be tailored according to the therapeutic effect desired using the device 100. For example, for an infected skin condition, the relative power which can be emitted by the first LED set can be increased, whereas for a cosmetic treatment the relative power which can be emitted by the second LED set may be increased.

In certain embodiments, the LEDs are equally spaced apart. The distance between the LEDs on the panel may be any distance such as about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another. In certain embodiments, the LEDs are spaced apart by about 10-12 mm in one direction and about 13-18 mm in another direction.

The LEDs may be more closely arranged if a higher power is required from the device 100. In certain other embodiments, the LEDs are not equally spaced apart.

Optionally, the device 100 may include a removable mask (cover) to reduce the size of the emitting area of the head 100. The device may be configured to deliver light with substantially equal distribution across an exposed surface with or without use of the mask. The head may have a U-shape, a circular shape, or any other suitable shape for a lamp head. The device 100 may also include filters to filter the light emitted from the emitting surface 112 in order to emit light of an appropriate wavelength, bandwidth or power density. The filters may include a UV filter, a collimator, a reflector or any other means for shaping the light from the device 100.

FIG. 5 is an emission spectra of a different embodiment of the device, measured in the same manner as FIG. 3, which differs from the embodiment described above in that the second set of LEDs has a higher peak wavelength, of 450 to about 480 nm, and the head comprises three panels which are positioned to wrap around a part or a whole of a contoured body part such as the face, arms, legs. In this embodiment, the average power density at a treatment distance is less than about 75 mW/cm^2, or about 30 to 150 mW/cm^2.

In another embodiment of the device, the peak wavelength of the light from the first light source is about 430 to about 500 nm, about 440 to about 500 nm, about 450 to about 500 nm, about 430 to about 475 nm, about 435 nm to about 470 nm, about 440 nm to about 460 nm, about 445 nm to about 455 nm, about 440 nm, about 450 nm, about 460 nm or about 470 nm. The peak wavelength of the light from the second light source may be about 400 nm to about 500 nm, about 400 nm to about 475 nm, about 400 nm to about 450 nm, about 400 nm to about 430 nm, about 410 nm to about 420 nm, or about 415 nm.

Alternatively, the second peak wavelength may be about 480 to about 760 nm, about 480 nm to about 700 nm, about 480 nm to about 650 nm, about 480 nm to about 620 nm, about 500 to about 700 nm, about 520 nm to about 700nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm, about 540 nm to about 580 nm, about 500 nm to about 570 nm, about 570 nm to about 590 nm, about 590 nm to about 610 nm, or about 610 nm to about 760 nm. In certain embodiments, light from the second light source has a broader bandwidth than the light from the first light source, and a lower average power.

Another embodiment of the device differs from those above in that instead of the first and second light sources emitting light having different peak wavelengths, there is provided at least one light source which emits a light, such as white light, which is transformed to the required spectra by one or more filters. The at least one light source is an array of LEDs or other light sources emitting white light. The filters comprise coloured transparent sheets, such as those used in stage lighting, which can remove the unwanted light allowing only the beneficial light to pass therethrough to a treatment site. In another embodiment, the filter may incorporate a fluorescent agent.

The light emitting surface of the device may comprise one or more waveguides such as a fibre optic, or a bundle of fibre optics connectable to the one or more light sources. The fibre optics may be made of any material with suitable light carrying and tensile properties, such as polymethylmethacrylate (PMMA). The fibre optic(s) may be encased in a sleeve. The fibre optics can thus be used to deliver the therapeutic light from the device to an internal cavity of a subject or a hard to reach treatment area on the subject.

Referring now to the controller 114, by means of the controller, different treatment parameters can be pre-set as a treatment mode, or can be customized by the device operator. For example, the controller 114 may allow the user to select specific peak wavelengths, such as red, yellow, blue and/or infrared wavelengths, or a combination thereof to treat various conditions, such as skin conditions or wounds. Additional light color types may also be used. In this case, the device includes different sets of LEDs per desired peak wavelength. The controller 114 may optionally include a display (not shown) that assists a user in selecting and controlling treatment modes, timers, and other functionality features.

The controller 114 can illuminate different sets of LEDs, or other light sources, having different emission spectra such as peak wavelengths simultaneously or at separate times. It may be desirable to activate the different light sources simultaneously such that the effects of irradiation by the different light sources take place simultaneously. In addition, the combination of the two or more emission spectra may introduce a synergistic effect which may result in more efficient treatment than the single application of either emission spectra at a time. Alternatively, it may be desirable to activate one emission spectra at a time. Operating a phototherapeutic lamp within a single emission spectra may be desirable if no synergistic effects are expected from operating at multiple emission spectra simultaneously, or if it is determined that doing so has a detrimental effect. It may also be desirable to alternate between two or more emission spectra. For example, in weekly treatments for acne, alternating between two wavelength ranges (e.g., 633 nm (red) and 415 nm (violet)) may result in more efficient treatment than using one wavelength range alone.

Treatment modes may be stored on a memory device or database in a machine readable form as described in relation to the device in **FIG. 6**. For example, a user may select one or more of a list of skin conditions or medical conditions to be treated. With treatment modes stored on a memory device or database, the lamp controller can access operating parameters of the phototherapeutic lamp that correspond with a particular light therapy treatment. Such parameters may include a dosage as defined by a treatment time, an average power, a treatment distance, a peak wavelength and a bandwidth, and may be inputted by a manufacturer or programmer of the device, or alternatively a user may provide adjustment operating parameter in accordance with a customized phototherapeutic treatment program.

The circuitry in the device may include a switch to select a mode of operation. The switch may be implemented in hardware, software, firmware, or a combination thereof. Different modes of operation may specify various parameters of the generated light, such as the wavelength range, bandwidth, peak wavelength, or any other light source parameter. In addition, a light source may be configured to produce pulses of light. In pulsating light sources, stronger intensities may be used to deliver a same amount of energy in a same amount of time as a non-pulsating light source. Pulsating may therefore be desirable for delivering stronger intensity light for a short amount of time and may accelerate the efficiency of a treatment. In this case, different modes may include different pulsation parameters, such as the pulse duration, the pulse frequency, the pulse intensity, the number of pulses, or any other pulsation parameter. In some cases, it may be desirable to keep the pulse parameters constant throughout a treatment session, such that the same pulse is delivered repeatedly. In other cases, it may be desirable to vary one or more pulse parameters over time across multiple pulses within the same session. For example, it may be desirable to operate in a mode where the pulse intensity increases with each pulse. In another example, it may be desirable to alternate between two or more wavelength ranges with each pulse. The parameters of the generated light (non-pulsating or pulsating) may be adjusted for any number of paradigms.

Different modes of operation may also include illuminating different sets of the light sources, such as the LEDs, at different times. For example, only one of the LED sets may be illuminated in a mode, or a selected number of the LEDs within a set. This may be desired if the area requiring treatment (e.g., a wound) is small such that illuminating all the LEDs would treat a larger region than required. As an example, it may be desirable to treat an area of skin near the eye, but delivering light to the eye may cause damage. In this case, using a subset of the light generating sources is useful to appropriately control the size and shape of the region to be treated. In another example, when a mode includes using pulses, two subsets of the light generating sources may alternately pulse on and off such that only one subset of sources is illuminated at any given time. This mode may be selected when it is desirable to deliver a transient light with strong intensity to a subset of locations.

The device operator may directly select a mode of operation, or the device may include a user interface that allows the user to select one or more goals, and the device may be configured to select an appropriate mode based on the user's selection. For example, the device operator may indicate at the user interface that it is desirable to use a mode for treating acne, and an appropriate mode may be selected, such as a non-pulsating emission with a first emitted maximum peak of about 400 nm to about 430 nm at a full width half maximum bandwidth of about 14 nm, and a second maximum peak of about 440 to about 470nm, or any other suitable mode for treating acne.

The modes selected by the circuitry of the device or by the operator may be appropriately adjusted to be within levels that are safe and comply with regulatory requirements in any country.

In certain embodiments, the device includes a sensor in communication with the controller and feedback mechanism such that device output is related to various parameters that the sensor detects. The sensor may be an optical, thermal or biometric sensor or the like. For example, if a thermal sensor senses that a pre-set temperature on or near the treatment site has been reached or is close to being reached, the device will adjust the emitted light parameters accordingly, for example by (i) lowering the power density and extending the treatment time extended to deliver the same dosage, (ii) reducing the dosage is reduced, (iii) turning the device off, (iv) activating an alarm, (v) activating the cooling system, if present, to cool around or within the treatment area, or (vi) adjusting an output of the cooling system, if present, e.g. rate of cooling or extent of cooling.

The sensor may be an optical sensor for detecting a light output from a photoactivatable composition which the device is irradiating, and in response to a detected emitted light, the device can, for example (i) turn off the lamp when the photoactivatable composition is spent (photobleached), (ii) adjust the emission spectra of the light irradiating the composition to account for variability of distance of the device from the composition or composition thickness. This can be considered a self-tuning mechanism to adapt the characteristics of the lamp based on the emission of the photoactivated composition.

In certain embodiments, the sensor is used to pair the photoactivatable composition to the device. For example, such that the lamp is enabled only when it sees a specific optical signature from the photoactivatable composition, or when it sees a specific bar code from a container of the composition. This can also be considered as a safety feature.

FIG. 6 is a block diagram of a computing device, which may be included in the device, for performing any of the processes described herein. Each of the components of these systems may be implemented on one or more computing devices 400. In certain aspects, a plurality of the components of these systems may be included within one computing device 400. In certain implementations, a component and a storage device may be implemented across several computing devices 400.

The computing device 400 comprises at least one communications interface unit, an input/output controller 410, system memory, and one or more data storage devices. The system memory includes at least one random access memory (RAM 402) and at least one read-only memory (ROM 404). All of these elements are in communication with a central processing unit (CPU 406) to facilitate the operation of the computing device 400. The computing device 400 may be configured in many different ways. For example, the computing device 400 may be a conventional standalone computer or alternatively, the functions of computing device 400 may be distributed across multiple computer systems and architectures. In FIG.S 4a to 4d, the computing device 400 is linked, via network or local network, to other servers or systems.

The computing device 400 may be configured in a distributed architecture, wherein databases and processors are housed in separate units or locations. Some units perform primary processing functions and contain at a minimum a general controller or a processor and a system memory. In distributed architecture implementations, each of these units may be attached via the communications interface unit 408 to a communications hub or port (not shown) that serves as a primary communication link with other servers, client or user computers and other related devices. The communications hub or port may have minimal processing capability itself, serving primarily as a communications router. A variety of communications protocols may be part of the system, including, but not limited to: Ethernet, SAP, SAS™, ATP, BLUETOOTH™, GSM and TCP/IP.

The CPU 406 comprises a processor, such as one or more conventional microprocessors and one or more supplementary co-processors such as math co-processors for offloading workload from the CPU 406. The CPU 406 is in communication with the communications interface unit 408 and the input/output controller 410, through which the CPU 406 communicates with other devices such as other servers, user terminals, or devices. The communications interface unit 408 and the input/output controller 410 may include multiple communication channels for simultaneous communication with, for example, other processors, servers or client terminals.

The CPU 406 is also in communication with the data storage device. The data storage device may comprise an appropriate combination of magnetic, optical or semiconductor memory, and may include, for example, RAM 402, ROM 404, flash drive, an optical disc such as a compact disc or a hard disk or drive. The CPU 406 and the data storage device each may be, for example, located entirely within a single computer or other computing device; or connected to each other by a communication medium, such as a USB port, serial port cable, a coaxial cable, an Ethernet cable, a telephone line, a radio frequency transceiver or other similar wireless or wired medium or combination of the foregoing. For example, the CPU 406 may be connected to the data storage device via the communications interface unit 408. The CPU 406 may be configured to perform one or more particular processing functions.

The data storage device may store, for example, (i) an operating system 412 for the computing device 400; (ii) one or more applications 414 (*e.g.*, computer program code or a computer program product) adapted to direct the CPU 406 in accordance with the systems and methods described here, and particularly in accordance with the processes described in detail with regard to the CPU 406; or (iii) database(s) 416 adapted to store information that may be utilized to store information required by the program.

The operating system 412 and applications 414 may be stored, for example, in a compressed, an uncompiled and an encrypted format, and may include computer program code. The instructions of the program may be read into a main memory of the processor from a computer-readable medium other than the data storage device, such as from the ROM 404 or from the RAM 402. While execution of sequences of instructions in the program causes the CPU 406 to perform the process steps described herein, hard-wired circuitry may be used in place of, or in combination with, software instructions for implementation of the processes of the present disclosure. Thus, the systems and methods described are not limited to any specific combination of hardware and software.

Suitable computer program code may be provided for performing one or more functions in relation to selecting a mode of operation as described herein. The program also may include program elements such as an operating system 412, a database management system and "device drivers" that allow the processor to interface with computer peripheral devices (*e.g.*, a video display, a keyboard, a computer mouse, *etc.*) via the input/output controller 410.

The term "computer-readable medium" as used herein refers to any non-transitory medium that provides or participates in providing instructions to the processor of the computing device 400 (or any other processor of a device described herein) for execution. Such a medium may take many forms, including but not limited to, non-volatile media and volatile media. Non-volatile media include, for example, optical, magnetic, or opto-magnetic disks, or integrated circuit memory, such as flash memory. Volatile media include dynamic random access memory (DRAM), which typically constitutes the main memory. Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, any other magnetic medium, a CD-ROM, DVD, any other optical medium, punch cards, paper tape, any other physical medium with patterns of holes, a RAM, a PROM, an EPROM or EEPROM (electronically erasable programmable read-only memory), a FLASH-EEPROM, any other memory chip or cartridge, or any other non-transitory medium from which a computer can read.

Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to the CPU 406 (or any other processor of a device described herein) for execution. For example, the instructions may initially be borne on a magnetic disk of a remote computer (not shown). The remote computer can load the instructions into its dynamic memory and send the instructions over an Ethernet connection, cable line, or even telephone line using a modem. A communications device local to a computing device 400 (*e.g.*, a server) can receive the data on the respective communications line and place the data on a system bus for the processor. The system bus carries the data to main memory, from which the processor retrieves and executes the instructions. The instructions received by main memory may optionally be stored in memory either before or after execution by the processor. In addition, instructions may be received via a communication port as electrical, electromagnetic or optical signals, which are exemplary forms of wireless communications or data streams that carry various types of information.

In certain embodiments, the device can be embodied or integrated into an existing item such as a mobile device such as a hand-held computing device, a smart phone, or a mobile telephone with a display screen, a camera flash or a flashlight as the emitting surface, e.g. iphone®, ipad®, Samsung galaxy®. Alternatively, the device can be embodied or integrated into a display screen of a desktop computer, television, a bath, a shower, a tanning bed, a body part covering such as a blanket, an item of clothing such as a robe, a glove, or the like.

Methods

Methods for treating a subject's skin, wound, lesion or other skin condition are also disclosed. The therapeutic benefits of the light reaching the subject's skin can be related to the wavelength of light and power density of the emitted light as well as the total emitted power over the treatment time.

In certain aspects, the method includes irradiating the subject's skin with light having an average power density of about 4 mW/cm^2 to about 150 mW/cm^2. In certain embodiments, when applying two or more sets of LEDs with different wavelength ranges, the power density of one set of LEDs may be restricted to be less than a threshold amount of another set of

LEDs. For example, the power density of one set may be restricted to be less than 10% of the power density of another set, or any other suitable threshold amount.

In other aspects, the method includes irradiating a photoactivatable composition applied on or near a treatment area on the tissue or the treatment area on the tissue with a first light having a first peak wavelength which can activate the photoactivatable composition; and irradiating the same or a different photoactivatable composition or the treatment area on the tissue said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first and the second peak wavelengths are in the blue and/or violet regions of the electromagnetic spectrum.

In yet other aspects, the method comprises irradiating said tissue with a first light having a first peak wavelength; and irradiating said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first peak wavelength is in the blue and/or violet regions of the electromagnetic spectrum.

In yet other aspects, the method comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

In yet other aspects, the method comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 19 nm ± about 5 nm.

In yet other aspects, the method comprises method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

In yet other aspects, the method comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and modulating at least one of the peak wavelength, bandwidth, power density or fluence of the first light during the irradiation of the tissue.

In yet other aspects, the method comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

In certain embodiments, light is applied to thetreatment area for a period of 1 second to 30 minutes. In certain embodiments, light is applied for a period of 1-30 seconds, 15-45 seconds, 30-60 seconds, 0.75-1.5 minutes, 1-2 minutes, 1.5-2.5 minutes, 2-3 minutes, 2.5-3.5 minutes, 3-4 minutes, 3.5-4.5 minutes, 4-5 minutes, 4-6 minutes, 5-7 minutes, 6-8 minutes, 7-9 minutes, 8-10 minutes, 9-11 minutes, 10-12 minutes, 11-13 minutes, 12-14 minutes, 13-15 minutes, 14-16 minutes, 15-17 minutes, 16-18 minutes, 17-19 minutes, 18-20 minutes, 19-21 minutes, 20-22 minutes, 21-23 minutes, 22-24 minutes, 23-25 minutes, 24-26 minutes, 25-27 minutes, 26-28 minutes, 27-29 minutes, or 28-30 minutes. The treatment time may range up to about 90 minutes, about 80 minutes, about 70 minutes, about 60 minutes, about 50 minutes, about 40 minutes or about 30 minutes. The treatment period will depend on the total joules of light energy delivered to the treatment site, so a higher emitted light power density will require a shorter time, and vice versa.

In certain embodiments, light is applied for up to about 90 minutes, about 80 minutes, about 70 minutes, about 60 minutes, about 50 minutes, about 40 minutes or about 30 minutes, for about 1 to about 30 minutes, for about 1 to about 25 minutes, for about 1 to about 20 minutes, for about 1 to about 19 minutes, for about 1 to about 18 minutes, for about 1 to about 17 minutes, for about 1 to about 16 minutes, for about 1 to about 15 minutes, for about 1 to about 14 minutes, for about 1 to about 13 minutes, for about 1 to about 12 minutes, for about 1 to about 11 minutes, for about 1 to about 10 minutes, for about 1 to about 9 minutes, for about 1 to about 8 minutes, for about 1 to about 7 minutes, for about 1 to about 6 minutes, for about 1 to about 5 minutes, for about 1 to about 4 minutes, or for about 1 to about 3 minutes

In some embodiments, the method for treating a subject's tissue (e.g. skin, wound, lesion or other skin condition) further includes applying a photoactivatable composition to the tissue prior to applying the light of a certain wavelength and power density, for example from an embodiment of the present device 100.

The photoactivatable composition may include one or more compositions. For example, the photoactivatable composition may include a photoactivator component ("photoactive agent") which can be activated by light of specific wavelength (i.e., actinic light). The photoactivator component comprises one or more photoactivator molecules which are activated by actinic light and accelerate the dispersion of light energy, which leads to the photoactivator carrying on a therapeutic effect on its own, or to the photochemical activation of other agents contained in the composition that could carry on a therapeutic effect (e.g., acceleration in the breakdown process of an oxidant such as peroxide) when such compound is present in the composition. The included photoactivators are illuminated by photons of a certain wavelength and excited to a higher energy state. When the photoactivators' excited electrons return to a lower energy state, they emit photons with a lower energy level, thus causing the emission of light of a longer wavelength (Stokes shift). In the proper environment, much of this energy transfer can be transferred to the other components of the photoactivatable composition or to the treatment site directly.

Suitable photoactivators can be fluorescent dyes (or stains), although other dye groups or dyes (biological and histological dyes, food colorings, carotenoids) can also be used. Combining photoactivators may increase photo-absorbtion by the combined dye molecules and enhance absorption and photo-biomodulation selectivity. Combining photoactivators may also result in a transfer of energy between the photoactivators. This creates multiple possibilities of generating new photosensitive, and/or selective photoactivator mixtures. Suitable photoactivators may include:

Chlorophyll dyes

Exemplary chlorophyll dyes include but are not limited to chlorophyll a; chlorophyll b; oil soluble chlorophyll; bacteriochlorophyll a; bacteriochlorophyll b; bacteriochlorophyll c; bacteriochlorophyll d; protochlorophyll; protochlorophyll a; amphiphilic chlorophyll derivative 1; and amphiphilic chlorophyll derivative 2.

Xanthene derivatives

Exemplary xanthene dyes include but are not limited to Eosin B (4',5'-dibromo,2',7'-dinitr- o-fluorescein, dianion); eosin Y; eosin Y (2',4',5',7'-tetrabromo-fluorescein, dianion); eosin (2',4',5',7'-tetrabromo-fluorescein, dianion); eosin (2',4',5',7'-tetrabromo-fluorescein, dianion) methyl ester; eosin (2',4',5',7'-tetrabromo-fluorescein, monoanion) p-isopropylbenzyl ester; eosin derivative (2',7'-dibromo-fluorescein, dianion); eosin derivative (4',5'-dibromo-fluorescein, dianion); eosin derivative (2',7'-dichloro-fluorescein, dianion); eosin derivative (4',5'-dichloro-fluorescein, dianion); eosin derivative (2',7'-diiodo-fluorescein, dianion); eosin derivative (4',5'-diiodo-fluorescein, dianion); eosin derivative (tribromo-fluorescein, dianion); eosin derivative (2',4',5',7'-tetrachlor- o-fluorescein, dianion); eosin; eosin dicetylpyridinium chloride ion pair; erythrosin B (2',4',5',7'-tetraiodo-fluorescein, dianion); erythrosin; erythrosin dianion; erythiosin B; fluorescein; fluorescein dianion; phloxin B (2',4',5',7'-tetrabromo-3,4,5,6-tetrachloro-fluorescein, dianion); phloxin B (tetrachloro-tetrabromo-fluorescein); phloxine B; rose bengal (3,4,5,6-tetrachloro-2',4',5',7'-tetraiodofluorescein, dianion); pyronin G, pyronin J, pyronin Y; Rhodamine dyes such as rhodamines include 4,5-dibromo-rhodamine methyl ester; 4,5-dibromo-rhodamine n-butyl ester; rhodamine 101 methyl ester; rhodamine 123; rhodamine 6G; rhodamine 6G hexyl ester; tetrabromo-rhodamine 123; and tetramethyl-rhodamine ethyl ester.

Methylene blue dyes

Exemplary methylene blue derivatives include but are not limited to 1-methyl methylene blue; 1,9-dimethyl methylene blue; methylene blue; methylene blue (16 .mu.M); methylene blue (14 .mu.M); methylene violet; bromomethylene violet; 4-iodomethylene violet; 1,9-dimethyl-3-dimethyl-amino-7-diethyl-a- mino-phenothiazine; and 1,9-dimethyl-3-diethylamino-7-dibutyl-amino-phenot- hiazine.

Azo dyes

Exemplary azo (or diazo-) dyes include but are not limited to methyl violet, neutral red, para red (pigment red 1), amaranth (Azorubine S), Carmoisine (azorubine, food red 3, acid red 14), allura red AC (FD&C 40), tartrazine (FD&C Yellow 5), orange G (acid orange 10), Ponceau 4R (food red 7), methyl red (acid red 2), and murexide-ammonium purpurate.

In some aspects of the disclosure, the one or more photoactivator can be independently selected from any of Acid black 1, Acid blue 22, Acid blue 93, Acid fuchsin, Acid green, Acid green 1, Acid green 5, Acid magenta, Acid orange 10, Acid red 26, Acid red 29, Acid red 44, Acid red 51, Acid red 66, Acid red 87, Acid red 91, Acid red 92, Acid red 94, Acid red 101, Acid red 103, Acid roseine, Acid rubin, Acid violet 19, Acid yellow 1, Acid yellow 9, Acid yellow 23, Acid yellow 24, Acid yellow 36, Acid yellow 73, Acid yellow S, Acridine orange, Acriflavine, Alcian blue, Alcian yellow, Alcohol soluble eosin, Alizarin, Alizarin blue 2RC, Alizarin carmine, Alizarin cyanin BBS, Alizarol cyanin R, Alizarin red S, Alizarin purpurin, Aluminon, Amido black 10B, Amidoschwarz, Aniline blue WS, Anthracene blue SWR, Auramine O, Azocannine B, Azocarmine G, Azoic diazo 5, Azoic diazo 48, Azure A, Azure B, Azure C, Basic blue 8, Basic blue 9, Basic blue 12, Basic blue 15, Basic blue 17, Basic blue 20, Basic blue 26, Basic brown 1, Basic fuchsin, Basic green 4, Basic orange 14, Basic red 2, Basic red 5, Basic red 9, Basic violet 2, Basic violet 3, Basic violet 4, Basic violet 10, Basic violet 14, Basic yellow 1, Basic yellow 2, Biebrich scarlet, Bismarck brown Y, Brilliant crystal scarlet 6R, Calcium red, Carmine, Carminic acid, Celestine blue B, China blue, Cochineal, Coelestine blue, Chrome violet CG, Chromotrope 2R, Chromoxane cyanin R, Congo corinth, Congo red, Cotton blue, Cotton red, Croceine scarlet, Crocin, Crystal ponceau 6R, Crystal violet, Dahlia, Diamond green B, Direct blue 14, Direct blue 58, Direct red, Direct red 10, Direct red 28, Direct red 80, Direct yellow 7, Eosin B, Eosin Bluish, Eosin, Eosin Y, Eosin yellowish, Eosinol, Erie garnet B, Eriochrome cyanin R, Erythrosin B, Ethyl eosin, Ethyl green, Ethyl violet, Evans blue, Fast blue B, Fast green FCF, Fast red B, Fast yellow, Fluorescein, Food green 3, Gallein, Gallamine blue, Gallocyanin, Gentian violet, Haematein, Haematine, Haematoxylin, Helio fast rubin BBL, Helvetia blue, Hematein, Hematine, Hematoxylin, Hoffman's violet, Imperial red, Indocyanin green, Ingrain blue, Ingrain blue 1, Ingrain yellow 1, INT, Kermes, Kermesic acid, Kernechtrot, Lac, Laccaic acid, Lauth's violet, Light green, Lissamine green SF, Luxol fast blue, Magenta 0, Magenta I, Magenta II, Magenta III, Malachite green, Manchester brown, Martius yellow, Merbromin, Mercurochrome, Metanil yellow, Methylene azure A, Methylene azure B, Methylene azure C, Methylene blue, Methyl blue, Methyl green, Methyl violet, Methyl violet 2B, Methyl violet 10B, Mordant blue 3, Mordant blue 10, Mordant blue 14, Mordant blue 23, Mordant blue 32, Mordant blue 45, Mordant red 3, Mordant red 11, Mordant violet 25, Mordant violet 39 Naphthol blue black, Naphthol green B, Naphthol yellow S, Natural black 1, Natural red, Natural red 3, Natural red 4, Natural red 8, Natural red 16, Natural red 25, Natural red 28, Natural yellow 6, NBT, Neutral red, New fuchsin, Niagara blue 3B, Night blue, Nile blue, Nile blue A, Nile blue oxazone, Nile blue sulphate, Nile red, Nitro BT, Nitro blue tetrazolium, Nuclear fast red, Oil red O, Orange G, Orcein, Pararosanilin, Phloxine B, Picric acid, Ponceau 2R, Ponceau 6R, Ponceau B, Ponceau de Xylidine, Ponceau S, Primula, Purpurin, phycobilins, Phycocyanins, Phycoerythrins. Phycoerythrincyanin (PEC), Phthalocyanines, Pyronin B, Pyronin G, Pyronin Y, Rhodamine B, Rosanilin, Rose bengal, Saffron, Safranin O, Scarlet R, Scarlet red, Scharlach R, Shellac, Sirius red F3B, Solochrome cyanin R, Soluble blue, Solvent black 3, Solvent blue 38, Solvent red 23, Solvent red 24, Solvent red 27, Solvent red 45, Solvent yellow 94, Spirit soluble eosin, Sudan III, Sudan IV, Sudan black B, Sulfur yellow S, Swiss blue, Tartrazine, Thioflavine S, Thioflavine T, Thionin, Toluidine blue, Toluyline red, Tropaeolin G, Trypaflavine, Trypan blue, Uranin, Victoria blue 4R, Victoria blue B, Victoria green B, Water blue I, Water soluble eosin, Xylidine ponceau, or Yellowish eosin.

Photoactivatable compositions may contain other compounds, such as oxygen-rich agents, oxygen-containing agents, pH controlling agents (e.g., sodium acetate, sodium hydroxide), light diffracting agents (e.g., porcelain crystals, hydroxylapatite), healing factors (e.g., hyaluronic acid, glucosamine), chelating agents (e.g., EDTA, EGTA), lipolysis stimulating agents (e.g., caffeine), and/or hydrophilic gelling agents (e.g., glucose, celluloses).

When used in combination with a photoactivatable composition, it may be particularly useful for the device to emit at more than one peak wavelength. For example, when the light sources are LEDs, more than one type of LED is included in the device, each LED emitting at a different wavelength. For example, each LED may emit light at a wavelength that overlaps or matches the absorption band of the one or more chromophores in the photoactivatable composition. Each type of LED may be switched on and off independently.

In certain embodiments, the method includes i) applying a photoactivatable composition to a subject's skin, ii) applying light having a wavelength that overlaps an absorption spectra of the applied photoactivatable composition, wherein the light is applied for a period of time until the photoactivable composition is substantially photobleached.

In certain embodiments, the method includes i) applying a photoactivatable composition to a subject's skin, ii) applying a first light having a wavelength that overlaps an absorption spectra of the applied photoactivatable composition, wherein the first light is applied for a period of time until the photoactivable composition is substantially photo-bleached, and iii) applying a second light having a wavelength that is different than the first light.

In a particular embodiment, the method includes i) applying a photoactivatable composition to a subject's skin, wherein the photoactivatable composition absorbs light in the blue portion of the visible electromagnetic spectrum, ii) applying blue light to the subject's skin, wherein the blue light is applied until the photoactivatable composition is substantially photo-bleached, and iii) applying red light to the subject's skin.

In certain embodiments, the method comprises irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and modulating at least one of the peak wavelength, bandwidth, power density or fluence of the first light during the irradiation of the tissue. In one implementation, the method comprises decreasing or increasing the maximum power intensity of the light emitted from at least one light source during the time of light irradiation. Lights from different light sources may be modulated differently, at different times or at the same time. It will be understood that that the modulation of light from one light source may occur over only a portion of the total irradiation time, or over the full irradiation time. In certain embodiments, the power density may be increased or decreased at a rate, for example, of at about 0.002 mW/cm^2 per minute of irradiation to about 0.1 mW/cm^2 per minute of irradiation, about 0.005 mW/cm^2 per minute, about 0.006 mW/cm^2 per minute, or about 0.012 mW/cm^2 per minute.

The treatment area may be irradiated simultaneously or at different times, from a single light source or a plurality of light sources with light having different properties. The irradiating light may have any of the properties described above in relation to aspects of the device and lamp.

In certain embodiments, the irradiating light is a fluorescence or phosphorescence light within one or more of the green, yellow, orange, red and infrared portions of the electromagnetic spectrum, for example having a peak wavelength within the range of about 490 nm to about 720 nm. In one embodiment, the irradiating light has a wavelength of between about 400 nm to about 700 nm, about 480 nm to about 700 nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm. In another embodiment, the irradiating light has a power density of between 0.005 to about 10 mW/cm^2, about 0.5 to about 5 mW/cm^2. In certain embodiments, the irradiating light has a bandwidth of about 15 nm to about 100nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm. The light source of the irradiating light may be a photoactive agent such as a fluorochrome which is activated by the first light source, or any other light source, to emit fluorescence. Alternatively, the irradiating light may be from an electronically generated light such as LED, laser etc which mimics a fluorescence or phosphorescence spectra.

In certain embodiments, the maximum power density of the irradiating light is from about 0.01 mW/cm^2 to about 200 mW/cm^2, 0.02 mW/cm^2 to about 150 mW/cm^2, 0.02 mW/cm^2 to about 135 mW/cm^2, 0.02 mW/cm^2 to about 75 mW/cm^2, 0.02 mW/cm^2 to about 60 mW/cm^2, about 0.02 mW/cm^2 to about 50 mW/cm^2, about 0.02 mW/cm^2 to about 30 mW/cm^2, about 0.02 mW/cm^2 to about 15 mW/cm^2.

In certain other embodiments, the light generated from the array of LEDs or other light source is pulsed. In certain embodiments, the light generated has a pulse duration between about 10 ms and about 300 ms. However, a longer and shorter pulse duration can be used depending on the application. In some embodiments, the light generated has a pulse duration between about 20 ms and about 100 ms. In some embodiments, the light generated has a pulse duration between about 20 ms and about 60 ms. In some embodiments, the beam of radiation has a pulse duration between about 20 ms and about 40 ms. In some embodiments, the light generated has a pulse duration between about 40 ms and about 60 ms. In some embodiments, the light generated has a pulse duration of about 40 ms. In some embodiments, the light generated has a pulse duration greater than about 40 ms. In some embodiments, the light generated has a pulse duration of less than 1 ms, and preferably less than 500 ns. In addition, the pulse duration may be dependent on other characteristics of the generated light, such as the amplitude, wavelength, bandwidth, or a combination thereof.

The method may also include filtering, attenuating, amplifying, polarizing, or otherwise modifying the emitted light by one or more optical elements before it reaches an area of tissue, e.g. skin, to which it is directed. For example, the light may be filtered by a filter which removes a certain bandwidth of light such as a UV filter. The light may also be collimated.

In certain embodiments, the phototherapeutic device may also be used in combination with a shield that effectively blocks the light being emitted from the LEDs of the device. For example, when only a portion of the subject's skin surface requires treatment, a shield may be used to prevent the emitted light from being applied to the area of skin not requiring treatment.

Uses

The systems, devices, and methods of the present disclosure enable the use of light therapy technology for a variety of cosmetic, health and medical applications. Photomodulation of cellular activity induced by light has been found beneficial in skin therapy or treatment methods. The systems, devices and methods of the present disclosure may be useful in the treatment of a wound and tissue repair, skin condition, skin rejuvenation and skin maintenance and acute inflammation.

"Skin rejuvenation" means a process of reducing, diminishing, retarding or reversing one or more signs of skin aging. For instance, common signs of skin aging include, but are not limited to, appearance of fine lines or wrinkles, thin and transparent skin, loss of underlying fat (leading to hollowed cheeks and eye sockets as well as noticeable loss of firmness on the hands and neck), bone loss (such that bones shrink away from the skin due to bone loss, which causes sagging skin), dry skin (which might itch), inability to sweat sufficiently to cool the skin, unwanted facial hair, freckles, age spots, spider veins, rough and leathery skin, fine wrinkles that disappear when stretched, loose skin, or a blotchy complexion. According to the present disclosure, one or more of the above signs of aging may be reduced, diminished, retarded or even reversed by the devices, methods, uses and systems of the present disclosure.

"Skin disorders" include, but are not limited to, erythema, telangiectasia, actinic telangiectasia, psoriasis, skin cancer, pemphigus, sunburn, dermatitis, actinic keratosis, eczema, rashes, acne, impetigo, lichen simplex chronicus, rhinophyma, perioral dermatitis, diffuse sebaceous glands hyperplasia, other sebaceous gland disorders, collagen-related skin diseases (connective tissue disorders), other sweat gland disorders, granulomatous skin conditions, vascular lesions, benign pigmented lesions, hair disorders and some skin infections, chronic and acute inflammation, pseudofolliculitis barbae, drug eruptions, erythema multiforme, erythema nodosum, granuloma annulare, actinic keratosis, purpura, alopecia areata, aphthous stomatitis, drug eruptions, dry skin, neoplastic disorders, chapping, xerosis, ichthyosis vulgaris, fungal infections, herpes simplex, intertrigo, keloids, keratoses, milia, moluscum contagiosum, pityriasis rosea, pruritus, urticaria, and vascular tumors and malformations. Dermatitis includes contact dermatitis, atopic dermatitis, seborrheic dermatitis, nummular dermatitis, generalized exfoliative dermatitis, and statis dermatitis. Skin cancers include melanoma, basal cell carcinoma, and squamous cell carcinoma.

Some types of acne include, for example, acne vulgaris, cystic acne, acne atrophica, bromide acne, chlorine acne, acne conglobata, acne cosmetica, acne detergicans, epidemic acne, acne estivalis, acne fulminans, halogen acne, acne indurata, iodide acne, acne keloid, acne mechanica, acne papulosa, pomade acne, premenstral acne, acne pustulosa, acne scorbutica, acne scrofulosorum, acne urticata, acne varioliformis, acne venenata, propionic acne, acne excoriee, gram negative acne, steroid acne, and nodulocystic acne.

Some skin disorders present various symptoms including redness, flushing, burning, scaling, pimples, papules, pustules, comedones, macules, nodules, vesicles, blisters, telangiectasia, spider veins, sores, surface irritations or pain, itching, inflammation, red, purple, or blue patches or discolorations, moles, and/or tumors.

"Wound" means an injury to any tissue, including for example, acute, subacute, delayed or difficult to heal wounds, and chronic wounds. Examples of wounds may include both open and closed wounds. Wounds include, for example, burns, incisions, excisions, lacerations, abrasions, puncture or penetrating wounds, surgical wounds, contusions, hematomas, crushing injuries, sores (such as for example pressure sores), ulcers, wounds caused by periodontitis (inflammation of the periodontium). Ulcers can include diabetic foot ulcers, pressure ulcers, amputations, venous ulcers, chronic ulcers and/or any wound that may be classified as being Grade I through Grade IV wounds.

“Acute inflammation” can present itself as pain, heat, redness, swelling and loss of function. It includes those seen in allergic reactions such as insect bites e.g.; mosquito, bees, wasps, poison ivy, post-ablative treatment.

Identification of equivalent devices, methods and uses are well within the skill of the ordinary practitioner and would require no more than routine experimentation, in light of the teachings of the present disclosure. Practice of the disclosure will be still more fully understood from the following examples, which are presented herein for illustration only and should not be construed as limiting the disclosure in any way.

EXAMPLES

The examples below are given so as to illustrate the practice of various embodiments of the present disclosure. They are not intended to limit or define the entire scope of this disclosure.

Example 1 – Angiogenic potential of light treatment using embodiments of the present disclosure

A human skin model was developed to assess the angiogenic potential of light emitted by devices, systems and methods of the present disclosure. Briefly, a human skin model containing fibroblasts and keratinocytes was illuminated for 5 minutes by a system according to an embodiment of the present disclosure which provided light having the profile shown in **FIGS. 7a and 7b**, as measured using Spectroradiometer (SP-100 from ORB Optronix), and showing the power intensity over time of the light treatment received by the cells in the skin model of this Example.

Specifically, the light being received by the skin model comprised a first peak having a wavelength range of from about 400 to about 470 nm and a peak wavelength at about 450 nm, and a second peak having a wavelength range of from about 520 nm to about 620 nm and a peak wavelength at around 540-580 nm. At the treatment distance (10 cm from the skin model), the maximum power at the peak wavelength of the first peak was around 1.5 - 2 mW/cm^2/nm, and of the second peak was about 0.01 mW/cm^2/nm (about 0.5% of the first peak). The total power of the first peak ranged from about 35-55 mW/cm^2 (about 38-45 mW/cm^2) during a treatment time of 5 minutes. The total power of the second peak ranged from about 0.05-0.6 mW/cm^2 (about 0.4-0.5 mW/cm^2) and was up to about 0.1-1.5% (about 1%) of the first peak total power. The second peak had a bandwidth of about 20-60 nm, about 40-60 nm, which was broader than the bandwidth of the first peak (about 20 nm). In the 5 minute treatment time, the skin model received a fluence of about 10-20 J/cm^2, about 15 J/cm^2. The second dominant peak was about 0.3-1% (about 0.6%) of the total light fluence received by the skin model during the 5 minutes of treatment. The relative ratio of the power density of light (activating light to fluorescent light) received by the skin model varied during the treatment time.

The system providing the light illuminating the skin model comprised a lamp which emitted an 'activating' blue light (having an emission profile similar to that illustrated in **FIG. 3**) and a composition containing a fluorescent agent (e.g. Eosin) which was activated by the lamp to emit a fluorescent light. Specifically, lamp had two sets of LED's with peak wavelengths of 410-420 nm and 440-470 nm. At a 10cm distance from the LEDs, the activating light had a peak wavelength of about 450 nm, a power at the peak wavelength of about 2-3 $mW/cm^2/nm$ (about 2.5 $mW/cm^2/nm$), an average power of about 55-65 mW/cm^2, and a fluence in 5 minutes of irradiation of about 15-25 J/cm^2 (about 16-20 J/cm^2).

The skin model and the biophotonic composition were separated by a nylon mesh of 20 micron pore size. The skin model was illuminated substantially simultaneously by both the activating light and the fluorescent light.

Since the biophotonic composition was in limited contact with the cells, the fibroblasts and keratinocytes were exposed mainly to the activating light and the fluorescent light emitted from the biophotonic composition. Conditioned media from the treated human 3D skin model were then applied to human aortic endothelial cells and diseased microvascular endothelial cells from Diabetic patients previously plated in Matrigel™. The formation of tubes by endothelial cells was observed and monitored by microscopy after 24 hours. The conditioned medium from the illuminated 3D skin models treated with light illumination induced endothelial tube formation in vitro from both cell types, suggesting an indirect effect of the light treatment (a light with two peaks having peak wavelengths in the blue and green spectra) on angiogenesis via the production of factors by fibroblasts and keratinocytes. Plain medium and conditioned medium from untreated skin samples were used as a control, and did not induce endothelial tube formation.

Example 2- Protein secretion and gene expression profiles

Wounded and unwounded 3D human skin models (EpiDermFT, MatTek Corporation) were used to assess the potential of light emitted by devices, systems and methods of the present disclosure to trigger distinct protein secretion and gene expression profiles. Briefly, wounded and unwounded 3D human skin models cultured under different conditions (with growth factors, 50% growth factors and no growth factors) were illuminated for 2 minutes by light having a profile similar to that shown in **FIGS. 7a and 7b**. The system illuminating the skin models comprised a lamp which emitted an 'activating' blue light and a composition containing two fluorescent agents (Eosin and erythrosine) which was activated by the lamp to emit a fluorescent light.

The skin models and the composition were separated by a nylon mesh of 20 micron pore size, and the lamp was positioned about 10 cm from the skin models. The skin model was illuminated substantially simultaneously by both the activating light and the fluorescent light. The controls consisted of 3D skin models not illuminated with light.

Gene expression and protein secretion profiles were measured 24 hours after light exposure. Cytokine secretion was analyzed by antibody arrays (RayBio Human Cytokine antibody array), gene expression was analyzed by PCR array (PAHS-013A, SABioscience) and cytotoxicity was determined by GAPDH and LDH release. Results (Tables 1 and 2) showed that the light treatment is capable of increasing the level of protein secreted and gene expression involved in the early inflammatory phase of wound healing in wounded skin inserts and in non-starvation conditions. Interestingly, the effect of the light treatment on unwounded skin models has a much lower impact at the cellular level than on wounded skin insert, which suggests an effect at the cellular effect level of the light treatment. It seems to modulate the mediators involved in inflammation. Due to the lack of other cell types such as macrophages in the 3D skin model, the anti-inflammatory feed-back is absent and may explain the delay in wound closure. Cytotoxicity was not observed in the light treatments.

Table 1 – List of proteins with statistically significant difference secretion ratio between treated and untreated control at day 3. Two arrows mean that the ratio was over 2 folds.

	Medium 1X	**Medium 0.5X**	**Medium 0X**
Increase		**ENA78 p=0.04** ↑↑ **Il-1R4/ST2 p=0.02** ↑↑ **MMP3 p=0.01** ↑↑ **MCP-2 p=0.04** ↑↑	Angiogenin p=0.03 ↑ CXCL16 p=0.04 ↑
Decrease	BMP6 p=0.01 ↓ TNFα p=0.005 ↓	BMP6 p=0.02 ↓	

Table 2 – List of genes with statistically significant difference expression ratio between treated and untreated control during the first 24 hours. Two arrows mean that the ratio was over 2 folds.

	Medium 1X	**Medium 0.5X**	**Medium 0X**

Increase	CTGF p=0.02 ↑ ITGB3 p=0.03 ↑ MMP1 p=0.03 ↑ MMP3 p=0.01 ↑ THBS1 P=0.02 ↑	CTGF P=0.04 ↑ ITGB3 p=0.05 ↑ **MMP1 p=0.02** ↑↑ **MMP10 p=0.003** ↑↑ **MMP3 p=0.007** ↑↑ **MMP8 p=0.02** ↑↑ THBS1 p=0.03 ↑	**MMP3 p=0.007** ↑↑ LAMA1 p=0.03 ↑ ITGA2 p=0.03 ↑
Decrease	HAS1 p=0.009 ↓↓ NCAM1 p=0.05 ↓↓ VCAM1 p=0.03 ↓↓ COL7A1 p=0.04 ↓ CTNNA1 p=0.03 ↓	**NCAM1 p=0.02** ↓↓ VCAN p=0.02 ↓ LAMC1 p=0.002 ↓ COL6A1 p=0.007 ↓ MMP7 p=0.003 ↓	

Example 3 – Varying power density with time and distance

FIG. 8 and **FIG. 9** illustrate how an appropriate light treatment or system regimen may be selected for medical or cosmetic therapy according to embodiments of the present disclosure by varying the distance of the light source from the treatment site to alter the total power or fluence of the emitted peak. Furthermore, if there are two light sources with two peaks, the relative power of each may vary over time, **FIG. 8** illustrates the decrease in total power over a 5 minute treatment time. **FIG. 9** illustrates an increase in total power over time. In one embodiment, FIGS. 8 and 9 may be generated by a system comprising a lamp with an emitting profile such as the one illustrated in FIG. 3 and a fluorescent composition, with FIG. 8 showing the decrease in total power of the emitted fluorescence of the composition with time, and FIG. 9 showing an increase in the power of the lamp being transmitted through the biophotonic composition.

Example 3 - Collagen formation

Dermal human fibroblasts were illuminated with light and assessed with regard to collagen formation. Dermal human fibroblasts were plated in glass-bottomed dishes with wells (MatTek®). There were approximately 4000 cells per well. After 48 hours, the glass-bottomed dishes were inverted and the cells were treated through the glass bottom with (A) a no light (control), (B) sunlight exposure for about 13 minutes at noon (control), (C) sunlight plus a light having a peak wavelength of about 550-570 nm (with a wavelength range of about 480-620 nm), a maximum power at the peak wavelength of about 0.01 to about 0.065 $mW/cm^2/nm$, a total peak power of about 3-5 mW/cm^2, and a bandwidth of about 50-70nm, and (D) a light comprising two emission peaks, a first peak having a peak wavelength of about 440-460 nm, a bandwidth of about 18-23 nm, a total peak power of about 25-95 mW/cm^2, and a maximum power at the peak wavelength of about 1 to about 3.5 $mW/cm^2/nm$, and a second peak having a peak wavelength of about 550-570 nm, a bandwidth of about 50-70nm, a total peak power of about 3-5 mW/cm^2, and a maximum power at the peak wavelength of about 0.01 to about 0.065 $mW/cm^2/nm$ (shown in **FIG. 10a** and **FIG.10b**).

After the treatment, the cells were washed and incubated in regular medium for 48 hours. A collagen assay was then performed on the supernatant using the Picro-Sirius red method. This involved adding Sirius red dye solution in picric acid to the supernatant, incubating with gentle agitation for 30 minutes followed by centrifugation to form a pellet. The pellet was washed first with 0.1N HCl and then 0.5 N NaOH to remove free dye. After centrifugation, the suspension was read at 540 nm for collagen type I. The results are shown in Table 3.

Table 3 – A qualitative comparison of collagen type I concentration in a dermal human fibroblast supernatant exposed to treatment methods A, B, C and D as described above. ++ indicates collagen levels about twice as high as +, and +++ indicates collagen levels about three times as high as +.

	(A) No light (control)	(B) Sunlight (control)	(C) Sunlight + light with peak wavelength of about 550-570 nm	(D) Light with peak wavelength 440-460 nm and light with peak wavelength of about 550-570 nm
Collagen concentration	+	+	+++	+++

There was a statistical difference between the collagen levels induced by light (C) and (D) compared to the no light and sunlight alone controls.

Collagen generation is indicative of a potential for tissue repair including stabilization of granulation tissue and decreasing of wound size. It is also linked to reduction of fine lines, a decrease in pore size, improvement of texture and improvement of tensile strength of intact skin.

It is to be reasonably expected that the same or similar effects can be obtained with a device or a system providing substantially similar or equivalent light emission properties as the systems described in Examples 1-3. For example, the system can comprise a lamp and a light emitting compound.

Example 4 – Antibacterial effect

Bacterial suspensions of Propioniobacterium acnes (p.acnes) were placed in a 12 well plate and incubated at about 35°C for about 24h in an anaerobic chamber. The bacterial suspensions were illuminated with the following lamps according to embodiment of the present disclosure: (A) a first lamp emitting a single peak at around 440-470 nm having a bandwidth of about 18-22 nm, a total power of about 60-150mW/cm^2 at 5 cm distance from the suspension, and a total fluence irradiating the suspension after 5 minutes of illumination of about 18-39 J/cm^2. Total emission wavelength ranged from about 400-500nm. No UV; and (B) a second lamp with an emission profile similar to that of **FIG. 3**, emitting a first peak having a peak wavelength around 440-470 nm having a bandwidth of about 18-22 nm, and a second peak having a peak wavelength at around 410-420 nm, a total power of about 60-150 mW/cm^2 (about 125 mW/cm^2) at 5 cm, and a total fluence after 5 minutes of about 18-39 J/cm^2 (about 35 J/cm^2). Total emitted wavelength ranged from about 400-500nm. No UV was emitted.

The levels of bacterial growth were assessed by measuring the optical density of the bacterial suspensions before illumination, up to 2 hours after illumination. The results were compared with controls (bacterial suspensions with no light illumination, and media only without bacteria). The results are illustrated in **FIG. 11a** and **FIG. 11b. FIG. 11a** shows that illumination with lamp (A) for 5 minutes impacted the growth of p.acnes for up to at least 2 hours after illumination compared to bacterial growth with no illumination. **FIG. 11b** shows that illumination with lamp (B) for 5 minutes impacted the growth of p.acnes for up to at least 2 hours after illumination compared to bacterial growth with no illumination. Further, it was observed with both lamps A and B that the viability of the p.acnes was affected for about 20-25 hours after illumination. These results indicate a bacteriostatic effect on p.acnes, at least in the short-term following illumination, of lamps A and B, and a bactericidal effect on p. acnes in the longer term.

The lamps A and B were also shown to affect growth, at least in the short term (e.g. bacteriostatic), of other gram positive and gram negative bacterial strains including but not limited to staphylococcus aureus, methicillin-resistant staphylococcus aureus, clostridium difficile, klebsiella pneumonia and pseudomonas aeruginosa. The lamps also affected viability in the longer term (e.g. bacteriocidal) of some of these bacterial strains as well as other strains such as staphylococcus aureus and Staphylococcus epidermidis.

Use of these lamps with a biophotonic composition including a fluorescent dye was shown to have a complementary effect of bacteriotstatic and bactericidal on bacterial strains such as p.acnes.

It is to be understood that the foregoing description is merely illustrative and is not to be limited to the details given herein. While several embodiments have been provided in the present disclosure, it should be understood that the disclosed systems, devices, and methods, and their components, may be embodied in many other specific forms without departing from the scope of the disclosure.

Variations and modifications will occur to those of skill in the art after reviewing this disclosure. The disclosed features may be implemented, in any combination and subcombinations (including multiple dependent combinations and subcombinations), with one or more other features described herein. The various features described or illustrated above, including any components thereof, may be combined or integrated in other systems. Moreover, certain features may be omitted or not implemented.

Examples of changes, substitutions, and alterations are ascertainable by one skilled in the art and could be made without departing from the scope of the information disclosed herein. All references cited herein are incorporated by reference in their entirety and made part of this application.

We claim:

1. A device for phototherapy comprising:
   a first light source which can emit a first light having a first peak wavelength for activating a photoactivatable composition applied on or near a treatment area; and
   a second light source which can emit a second light having a second peak wavelength which is different from the first peak wavelength, wherein the first and the second peak wavelengths are in the blue and/or violet regions of the electromagnetic spectrum.

2. A device for phototherapy comprising:
   a first light source which can emit a first light having a first peak wavelength; and
   a second light source which can emit a second light having a second peak wavelength which is different from the first peak wavelength, wherein the first peak wavelength is in the blue and/or violet regions of the electromagnetic spectrum.

3. The device of claim 1 or claim 2, wherein the first peak wavelength is about 430 to about 500 nm, about 440 to about 500 nm, about 450 to about 500 nm, about 430 to about 475 nm, about 435 nm to about 470 nm, about 440 nm to about 460 nm, about 445 nm to about 455 nm, about 440 nm, about 450 nm, about 460 nm or about 470 nm.

4. The device of any of claims 1 or claim 3, wherein the second peak wavelength is about 400 nm to about 500 nm, about 400 nm to about 475 nm, about 400 nm to about 450 nm, about 400 nm to about 430 nm, about 410 nm to about 420 nm, or about 415 nm.

5. The device of claim 1, wherein the second peak wavelength is from about 410 nm to about 430 nm, and the peak wavelength of the first light is from about 440 nm to about 470 nm.

6. The device of claim 2 or claim 3, wherein the second peak wavelength is about 480 to about 760 nm, about 480 nm to about 700 nm, about 480 nm to about 650 nm, about 480 nm to about 620 nm, about 500 to about 700 nm, about 520 nm to about 700nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm, about 540 nm to about 580 nm,

about 500 nm to about 570 nm, about 570 nm to about 590 nm, about 590 nm to about 610 nm, or about 610 nm to about 760 nm.

7. The device of claim 2 or claim 3, wherein the second peak wavelength is within the infrared range of the electromagnetic spectrum.

8. The device of any of claims 1 to 7, wherein at least one of the first and second lights has a bandwidth of equal to or less than about 20 nm.

9. The device of any of claims 1 to 7, wherein at least one of the first and second lights has a bandwidth of about 19 nm ± 5 nm.

10. The device of any of claims 1 to 7, wherein the second light has a bandwidth of between about 15 nm and about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

11. The device of any of claims 1 to 10, wherein the second light has a bandwidth which is broader than a bandwidth of the first light.

12. The device of claim 11, wherein the bandwidth of the first light is about 15 nm to about 25 nm and the bandwidth of the second light is about 20 nm to about 100 nm.

13. The device of any of claims 1 to 12, wherein an average power density of the light emitted by the device and/or received by a treatment area from the device is about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 200 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, or about 110 to about 135 mW/cm^2.

14. The device of any of claims 1 to 12, wherein an average power density of the light emitted by the device and/or received by a treatment area from the device is about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 85 mW/cm^2, about 10 to about 75 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 mW/cm^2 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

15. The device of any of claims 1 to 14, wherein an average power density of the second light is lower than an average power density of the first light.

16. The device of claim 15, wherein the average power density of the second light is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

17. The device of any of claims 1 to 16, wherein a fluence of the light emitted by the device and/or received by a treatment area from the device, during a single treatment, is more than about 4 J/cm^2, more than about 10 J/cm^2, more than about 15 J/cm^2, more than about 30 J/cm^2, more than about 50 J/cm^2, up to about 60 J/cm^2.

18. The device of any of claims 1 to 16, wherein a fluence of the light emitted by the device and/or received by a treatment area from the device, during a single treatment, is about 4 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 50 J/cm^2, about 10 J/cm^2 to about 40 J/cm^2, about 10 J/cm^2 to about 30 J/cm^2, about 20 J/cm^2 to about 40 J/cm^2, about 15 J/cm^2 to about 25 J/cm^2, or about 10 J/cm^2 to about 20 J/cm^2.

19. The device of any of claims 1 to 18, wherein a fluence emitted by the second light source or delivered to the treatment area from the second light source is lower than a fluence emitted by the first light source or delivered to the treatment area from the first light source.

20. The device of claim 19, wherein the fluence emitted by the second light source or delivered to the treatment area from the second light source is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about

4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment.

21. The device of any of claims 1 to 7, wherein the second light has a larger bandwidth than the first light, and wherein the second light has a lower average power density than the first light.

22. The device of claim 21, wherein the second light has a lower fluence than the first light.

23. The device of any of claims 1 to 22, wherein the second light has a maximum power at second peak wavelength which is lower than a maximum power at the first peak wavelength of the first light.

24. The device of any of claims 1 to 23, further comprising a controller in electronic communication with the first and second light sources for varying a first emission spectrum of the first light and/or a second emission spectrum of the second light, wherein the first and second emission spectra include one or more emission spectra parameters selected from a bandwidth, the peak wavelength, a power density, a time of emission and a fluence.

25. The device of claim 24, wherein the controller can control separately one or more of the emission spectra parameters of each of the first and second lights.

26. The device of claim 24 or claim 25, wherein the controller is arranged to modulate one or more of the emission spectra parameters of the first and second lights as a function of treatment time.

27. The device of any of claims 1 to 26, further comprising a third light source, wherein the third light source can emit a third light having a peak wavelength of about 500 nm to about 750 nm, about 630 to about 750 nm, or about 750 nm to about 1 mm.

28. The device of any of claims 1 to 27, wherein the first and second light sources can emit non-coherent light.

29. The device of any of claims 1 to 28, wherein the first and/or second light sources comprise one or more light emitting diodes (LEDs).

30. The device of any of claims 1 to 29, wherein the first and second light sources are arranged as an array on at least one panel.

31. The device of claim 30, wherein the first and second light sources are spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another.

32. The device of claim 30 or claim 31, comprising a plurality of connectable panels which are moveable with respect to one another.

33. The device of claim 32, comprising a panel controller in electronic communication with the panels to separately control a light emission from the panels.

34. The device of any of claims 30 to 33, wherein the second light sources are interdispersed amongst the first light sources in the array.

35. The device of any of claims 1 to 34, wherein the first and second light sources are substantially equally spaced apart.

36. The device of any of claims 1 to 35, further comprising one or more filters for filtering the first light and/or the second light.

37. The device of any of claims 1 to 36, further comprising a collimator for collimating the first and/or the second light.

38. The device of any of claims 1 to 37, wherein the first light source and the second light source are on an emitting face of the device, the device further comprising a spacing probe extending from the emitting face to indicate a treatment distance.

39. The device of any of claims 1 to 38, further comprising at least one vent in a housing supporting the first and/or second light sources for cooling of the device.

40. A device for phototherapy comprising:

a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and an average power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

41. A device for phototherapy comprising:

a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 19 nm ± about 5 nm.

42. A device for phototherapy comprising:

a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

43. A device for phototherapy comprising:

a first light source which can emit a first light having a peak wavelength of about 400 to about 750 nm, and a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

44. The device of any of claims 41 to 43, wherein the first light has an average power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

45. The device of any of claims 40 to 42, wherein the first light has a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

46. The device of claim 40, claim 41 or claim 43, wherein the first light has a bandwidth of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

47. The device of claim 40, claim 42 or claim 43, wherein the first light has a bandwidth of about 19 nm ± about 5 nm.

48. The device of any of claims 40 to 47, wherein the first light source comprises an array of light emitting diodes (LEDs).

49. The device of any of claims 40 to 48, wherein the peak wavelength is about 400 to about 450 nm, about 450 to about 490 nm, about 490 to about 560 nm, about 560 to about 590 nm, about 590 to about 635 nm, or about 635 to about 720 nm.

50. The device of any of claims 40 to 49, further comprising a controller for varying a power density, a bandwidth, the peak wavelength, a time or an energy fluence of the first light during emission of the first light.

51. The device of claim 50, wherein the controller can reduce the power density of the first light during emission of the first light by the device.

52. The device of any of claims 48 to 51 when dependent on claim 48, wherein the first light sources are spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another.

53. The device of claim 48 or claim 52, wherein the array of LEDs is housed on a panel, and the device comprises one or more panels moveably connected to each other.

54. The device of claim 53, comprising a panel controller in electronic communication with the one or more panels to separately control the one or more panels.

55. The device of any of claims 40 to 54, further comprising one or more filters for filtering the first light.

56. The device of any of claims 40 to 55, further comprising a collimator for collimating the first light.

57. The device of any of claims 40 to 56, wherein the first light source is on an emitting face of the device, the device further comprising a spacing probe extending from the emitting face to indicate a treatment distance.

58. The device of any of claims 40 to 57, further comprising at least one vent in a housing supporting the first light source for cooling.

59. The device of any of claims 40 to 58, further comprising a second light source having a peak wavelength which can emit a second light, wherein the second light comprises at least one of the following:

f) a bandwidth which is larger than a bandwidth of the first light,
g) an average power density which is lower than an average power density of the first light,
h) a power at the peak wavelength which is lower than a power at the peak wavelength of the first light,
i) a longer peak wavelength than the peak wavelength of the first light, or
j) a fluence which is lower during a treatment time than a fluence of the first light.

60. The device of claim 59, wherein the average power density of the second light is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

61. The device of claim 59, wherein the fluence emitted by the second light source or delivered to a treatment area from the second light source is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the

fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment.

62. The device of claim 59, wherein the bandwidth of the second light is more than 20 nm, about 20-100nm, about 20-80 nm, about 20-60 nm, about 20-40 nm.

63. The device of claim 59, wherein the power at a peak wavelength is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the power at a peak wavelength of the first light.

64. A lamp, comprising

a lamp head having a plurality of light emitting diodes (LEDs) arranged in an array, the array comprising at least a first set and a second set of LEDs, wherein each of the first and second sets include at least one LED;

a lamp controller electrically connected to the lamp head and having circuitry for controlling and operating the LEDs;

wherein the first set of LEDs can generate a first non-coherent light having a peak wavelength of about 430 nm to about 500 nm;

wherein the second set of LEDs can generate a second non-coherent light having a peak wavelength of about 400 nm to about 430 nm;

wherein a power density of light which can be generated by the lamp head or which can be received by a treatment surface is from about 4 to about 75 mW/cm^2, or from about 55 mW/cm^2 to about 150 mW/cm^2.

65. The lamp of claim 64, wherein the first set of LEDs can generate light having a bandwidth of about 19 nm ± 5 nm, or about 13 to about 26 nm.

66. The lamp of claim 64 or claim 65, wherein the second set of LEDs can generate light having a bandwidth of about 13 nm to about 20 nm.

67. The lamp of any of claims 64 to 66, further comprising a third set of LEDs, wherein the third set of LEDs generates non-coherent light having a peak wavelength of about 500 nm to 750 nm.

68. The lamp of any of claims 64 to 67, wherein the controller is arranged to vary one or more parameters of the first and/or the second light, the one or more parameters being selected from power density, bandwidth, wavelength, fluence and emission time.

69. The lamp of any of claims 64 to 68, wherein the first and second set of LEDs are spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another in the array.

70. The lamp of any of claims 64 to 69, wherein the LEDs of the first and second sets of LEDs are interdispersed amongst each other.

71. The lamp of any of claims 64 to 70, wherein the LEDs of the first and second sets of LEDs are substantially equally spaced apart in the array.

72. The lamp of any of claims 64 to 71, wherein the lamp head comprises a plurality of panels housing the LEDs, said panels being moveable with respect to each other.

73. The lamp of claim 72, wherein the lamp controller can control the LEDs of each of the panels separately.

74. The lamp of any of claims 64 to 73, further comprising one or more filters for filtering the first and/or second light.

75. The lamp of any of claims 64 to 74, further comprising a collimator for collimating the first and/or second lights.

76. The lamp of any of claims 64 to 75, wherein the array of the first and second set of LEDs are on an emitting face of the lamp, the lamp further comprising a spacing probe extending from the emitting face to indicate a treatment distance.

77. The lamp of any of claims 64 to 76, further comprising at least one vent in the lamp head for cooling.

78. The lamp of any of claims 64 to 77, wherein the lamp is arranged to emit or to deliver to a treatment surface a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

79. The lamp of any of claims 64 to 78, wherein the power density is from about 10 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, about 110 to about 135 mW/cm^2, about 10 to about 85 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

80. A lamp, comprising

a lamp head having a plurality of light emitting diodes (LEDs) arranged in an array, the array comprising at least a first set and a second set of LEDs, wherein each of the first and second sets include at least one LED;

a lamp controller electrically connected to the lamp head and having circuitry for controlling and operating the LEDs;

wherein the first set of LEDs can generate non-coherent light having a peak wavelength of about 400 nm to about 500 nm; wherein the second set of LEDs can generate non-coherent light having a peak wavelength of about 500 to about 760 nm;

wherein a power density of light which can be generated by the lamp head is from about 4 to about 75 mW/cm^2, or from about 55 to about 150 mW/cm^2.

81. The lamp of claim 80, wherein the first set of LEDs can generate light having a bandwidth of about 17 nm to about 23 nm.

82. A lamp of claim 80 or claim 81, wherein the second set of LEDs can generate light having a bandwidth of about 20 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 60 nm.

83. The lamp of any of claims 80 to 82, wherein the first set of LEDs can generate a higher power density than the second set of LEDs.

84. The lamp of any of claims 80 to 83, wherein the controller is arranged to vary one or more parameters of the first and/or the second light, the one or more parameters being selected from the power density, a bandwidth, the peak wavelength, a fluence and an emission time.

85. The lamp of any of claims 80 to 84, wherein the first and second set of LEDs are spaced about 4 to 7 mm, about 4 to 10 mm, about 10 to 15 mm, or about 15 to 20 mm apart from one another in the array.

86. The lamp of any of claims 80 to 85, wherein the LEDs of the first and second sets of LEDs are interdispersed amongst each other.

87. The lamp of any of claims 80 to 86, wherein the LEDs of the first and second sets of LEDs are substantially equally spaced apart in the array.

88. The lamp of any of claims 80 to 87, wherein the lamp head comprises a plurality of panels housing the LEDs, said panels being moveable with respect to each other.

89. The lamp of claim 88, wherein the lamp controller can control the LEDs of each of the panels separately.

90. The lamp of any of claims 80 to 89, further comprising one or more filters for filtering the first and/or second light.

91. The lamp of any of claims 80 to 90, further comprising a collimator for collimating the first and/or second lights.

92. The lamp of any of claims 80 to 91, wherein the array of the first and second set of LEDs are on an emitting face of the lamp, the lamp further comprising a spacing probe extending from the emitting face to indicate a treatment distance.

93. The lamp of any of claims 80 to 92, further comprising at least one vent in the lamp head for cooling.

94. The lamp of any of claims 80 to 93, wherein the lamp is arranged to emit or to deliver to a treatment surface a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

95. The lamp of any of claims 80 to 94, wherein the power density is from about 10 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, about 110 to about 135 mW/cm^2, about 10 to about 85 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

96. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, with a photoactivatable composition.

97. Use as claimed in claim 96, wherein the photoactivatable composition includes at least one photoactive agent having a peak excitation wavelength in the range of about 400 to about 700 nm, about 420 to about 540 nm, about 420 to about 590 nm, or about 450 nm to about 700 nm.

98. Use as claimed in claim 96 or claim 97, wherein the photoactive agent is a fluorescent agent.

99. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, for a cosmetic treatment of a tissue.

100. The use as claimed in claim 99, wherein the cosmetic treatment is selected from skin rejuvenation, skin conditioning, reducing pore size, increasing tissue luminosity, and reducing or diminishing scarring on the tissue.

101. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, for treatment of skin conditions.

102. The use as claimed in claim 101, wherein the skin conditions include acne, rosacea, psoriasis, eczema, dermatitis, inflammation and inflammatory skin conditions.

103. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, for wound healing.

104. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, for treating bacterial, viral or fungal infections.

105. Use of a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95, for providing a bacteriostatic and/or a bactericidal effect.

106. Use of a mobile device to activate a photoactivatable composition, wherein the mobile device can emit light having an emission spectra which overlaps an absorption spectra of a photoactive agent in the photoactivatable composition.

107. Use of a television or a computer monitor display screen to activate a photoactivatable composition, wherein the display screen can emit light having an emission spectra which overlaps an absorption spectra of a photoactive agent in the photoactivatable composition.

108. The use of claim 106 or claim 107, wherein the mobile device or the display screen has a light source which can photoactivate a photoactivatable composition in about 15 minutes, 30 minutes, 45 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7 hours or 8 hours of irradiation.

109. The use of any one of claims 106 to 108, wherein the photoactivatable composition includes at least one photoactive agent having a peak excitation wavelength in the range of about 400 to about 700 nm, about 420 to about 540 nm, about 540 nm to about 590 nm, about 590 to about 635 nm, or about 635 to about 700 nm.

110. The use of any one of claims 106 to 108, wherein the mobile device, television or computer monitor display screen comprises a device as claimed in any of claims 1 to 63; or a lamp as claimed in any of claims 64 to 95.

111. A method for cosmetic or medical treatment of tissue, said method comprising: irradiating a photoactivatable composition applied on or near a treatment area on the tissue or the treatment area on the tissue with a first light having a first peak wavelength which can activate the photoactivatable composition ; and
irradiating the same or a different photoactivatable composition or the treatment area on the tissue said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first and the second peak wavelengths are in the blue and/or violet regions of the electromagnetic spectrum.

112. A method for cosmetic or medical treatment of tissue, said method comprising: irradiating said tissue with a first light having a first peak wavelength; and
irradiating said tissue with a second light having a second peak wavelength, different from the first peak wavelength, wherein the first peak wavelength is in the blue and/or violet regions of the electromagnetic spectrum.

113. The method of claim 112, further comprising applying a photoactivatable composition on or near the treatment area on the tissue before irradiating the tissue.

114. The method of any of claims 111 to 113, wherein the first peak wavelength is about 430 to about 500 nm, about 440 to about 500 nm, about 450 to about 500 nm, about 430 to about 475 nm, about 440 nm to about 460 nm, about 445 nm to about 455 nm, about 435 nm to about 470 nm, about 440 nm, about 450 nm, about 460 nm or about 470 nm.

115. The method of any of claims 111 or claims 113-114 , wherein the second light has a peak wavelength of about 400 nm to about 500 nm, about 400 nm to about 475 nm, about 400 nm to about 450 nm, about 400 nm to about 430 nm, or about 410 nm to about 420 nm, about 415 nm.

116. The method claim 111, wherein the first peak wavelength is from about 410 nm to about 430 nm, and the second peak wavelength is from about 440 nm to about 470 nm.

117. The method of any of claims 112 to 114, wherein the second peak wavelength is about 480 to about 760 nm, about 480 nm to about 700 nm, about 480 nm to about 650 nm, about 480 nm to about 620 nm, about 500 to about 700 nm, about 520 nm to about 700nm, about 500 nm to about 660 nm, about 540 nm to about 640 nm, about 540 nm to about 580 nm, about 500 nm to about 570 nm, about 570 nm to about 590 nm, about 590 nm to about 610 nm, or about 610 nm to about 760 nm.

118. The method of any of claims 112 to 114, wherein the second peak wavelength is within the infrared range of the electromagnetic spectrum.

119. The method of any of claims 111 to 118, wherein at least one of the first and second lights has a bandwidth of equal to or less than about 20 nm.

120. The method of any of claims 111 to 119, wherein at least one of the first and second lights has a bandwidth of about 19 nm ± 5 nm.

121. The method of any of claims 111 to 118, wherein the second light has a bandwidth of between about 15 nm and about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

122. The method of any of claims 111 to 121, wherein the second light has a bandwidth which is broader than a bandwidth of the first light.

123. The method of claim 122, wherein the bandwidth of the first light is about 15 nm to about 25 nm and the bandwidth of the second light is about 20 nm to about 100 nm.

124. The method of any of claims 111 to 123, wherein an average power density emitted by the first and second lights and/or received by the treatment area is about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 200 mW/cm^2, about 10 to about 150 mW/cm^2, about 20 to about 130 mW/cm^2, about 55 to about 130 mW/cm^2, about 90 to about 140 mW/cm^2, about 100 to about 140 mW/cm^2, or about 110 to about 135 mW/cm^2.

125. The method of any of claims 111 to 123, wherein an average power density emitted by the first and second lights and/or received by the treatment area is about 4 to about 75 mW/cm^2, about 15 to about 75 mW/cm^2, about 10 to about 85 mW/cm^2, about 10 to about 75 mW/cm^2, about 30 to about 70 mW/cm^2, about 40 mW/cm^2 to about 70 mW/cm^2, about 55 to about 65 mW/cm^2, or about 55 to about 85 mW/cm^2.

126. The method of any of claims 111 to 125, wherein an average power density of the second light is lower than an average power density of the first light.

127. The method of claim 126, wherein the average power density of the second light is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the first light power density.

128. The method of any of claims 111 to 126, wherein a fluence of the light received by a treatment area, during a single treatment, is more than about 4 J/cm^2, more than about 10 J/cm^2, more than about 15 J/cm^2, more than about 30 J/cm^2, more than about 50 J/cm^2, up to about 60 J/cm^2.

129. The method of any of claims 111 to 126, wherein a fluence of the light received by a treatment area, during a single treatment, is about 4 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 60 J/cm^2, about 10 J/cm^2 to about 50 J/cm^2, about 10 J/cm^2 to about 40 J/cm^2, about 10 J/cm^2 to about 30 J/cm^2, about 20 J/cm^2 to about 40 J/cm^2, about 15 J/cm^2 to about 25 J/cm^2, or about 10 J/cm^2 to about 20 J/cm^2.

130. The method of claim 128 or claim 129, wherein the single treatment comprises irradiating the tissue or the photoactivatable composition for up to about 30 minutes, for about 1 to about 30 minutes, for about 1 to about 25 minutes, for about 1 to about 20 minutes, for about 1 to about 19 minutes, for about 1 to about 18 minutes, for about 1 to about 17 minutes, for about 1 to about 16 minutes, for about 1 to about 15 minutes, for about 1 to about 14 minutes, for about 1 to about 13 minutes, for about 1 to about 12

minutes, for about 1 to about 11 minutes, for about 1 to about 10 minutes, for about 1 to about 9 minutes, for about 1 to about 8 minutes, for about 1 to about 7 minutes, for about 1 to about 6 minutes, for about 1 to about 5 minutes, for about 1 to about 4 minutes, or for about 1 to about 3 minutes.

131. The method of any of claims 111 to 130, wherein a fluence delivered to the treatment area from the second light source is lower than a fluence emitted by the first light source or delivered to the treatment area from the first light source.

132. The method of claim 131, wherein the fluence delivered to the treatment area from the second light source is about 0.1% to about 90%, about 0.1% to about 80%, about 0.1% to about 70%, about 0.1% to about 60%, about 0.% to about 50%, about 0.1% to about 40%, about 0.1% to about 30%, about 0.1% to about 20%, about 0.1% to about 10%, about 0.1% to about 9%, about 0.1% to about 8%, about 0.1% to about 7%, about 0.1% to about 6%, about 0.1% to about 5%, about 0.1% to about 4%, about 0.1% to about 3%, about 0.1% to about 2%, about 0.1% to about 1%, of the fluence emitted by the first light source or delivered to the treatment area from the first light source, per treatment.

133. The method of any of claims 111 to 132, wherein the second light has a larger bandwidth than the first light, and wherein the second light has a lower average power density than the first light.

134. The method of claim 133, wherein the second light has a lower fluence than the first light.

135. The method of any of claims 111 to 134, wherein the second light has a maximum power at the peak wavelength which is lower than a maximum power at the peak wavelength of the first light.

136. The method of any of claims 111 to 135, further comprising varying an emission spectra of the first and/or second lights during a treatment time, wherein the emission spectra of each of the first and second lights include one or more emission spectra parameters selected from a bandwidth, a peak wavelength, a power density, a time of emission and a fluence.

137. The method of any of claims 111 to 136, wherein the first and/or second lights are generated by light emitting diodes (LEDs).

138. A method for cosmetic or medical treatment of a tissue, said method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

139. A method for cosmetic or medical treatment of a tissue, said method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 19 nm ± about 5 nm.

140. A method for cosmetic or medical treatment of a tissue, said method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

141. A method for cosmetic or medical treatment of tissue, said method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and modulating at least one of the peak wavelength, bandwidth, power density or fluence of the first light during the irradiation of the tissue.

142. A method for cosmetic or medical treatment of tissue, said method comprising irradiating the tissue with a first light having a peak wavelength of about 400 to about 750 nm, and and a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

143. The method of any of claims 139 to 141, wherein the first light has an average power density of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

144. The method of any of claims 138 to 142, wherein the first light has a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

145. The method of claim 138, claim 140 or claim 142, wherein the first light has a bandwidth of about 15 nm to about 100 nm, about 25 nm to about 80 nm, about 30 nm to about 70 nm, or about 20 nm to about 50 nm.

146. The method of any of claims 138 to claim 145, wherein the peak wavelength is about 400 to about 450 nm, about 450 to about 490 nm, about 490 to about 560 nm, about 560 to about 590 nm, about 590 to about 635 nm, or about 635 to about 720 nm.

147. The method of claim 142 or 144, wherein the single treatment comprises irradiating the tissue or a photoactivatable composition for up to about 30 minutes, for about 1 to about 30 minutes, for about 1 to about 25 minutes, for about 1 to about 20 minutes, for about 1 to about 19 minutes, for about 1 to about 18 minutes, for about 1 to about 17 minutes, for about 1 to about 16 minutes, for about 1 to about 15 minutes, for about 1 to about 14 minutes, for about 1 to about 13 minutes, for about 1 to about 12 minutes, for about 1 to about 11 minutes, for about 1 to about 10 minutes, for about 1 to about 9 minutes, for about 1 to about 8 minutes, for about 1 to about 7 minutes, for about 1 to about 6 minutes, for about 1 to about 5 minutes, for about 1 to about 4 minutes, or for about 1 to about 3 minutes.

148. A method for cosmetic or medical treatment of a tissue, said method comprising:

irradiating the tissue with non-coherent light from a first light source having a peak wavelength of about 430 nm to about 500 nm;

irradiating the tissue with non-coherent light from a second light source having a peak wavelength of about 400 nm to about 430 nm; wherein the tissue is irradiated with a total power density of light of about 4 to about 75 mW/cm^2, or about 55 mW/cm^2 to about 150 mW/cm^2.

149. The method of claim 147, further comprising applying a photoactivatable composition to the tissue prior to irradiating with the light.

150. The method of claim 148 or claim 149, wherein the first and the second lights have a fluence during a single treatment of about 4 to about 60 J/cm^2, about 10 to about 60 J/cm^2, about 10 to about 50 J/cm^2, about 10 to about 40 J/cm^2, about 10 to about 30 J/cm^2, about 20 to about 40 J/cm^2, about 15 J/cm^2 to 25 J/cm^2, or about 10 to about 20 J/cm^2.

151. The method of claim 150, wherein the single treatment comprises irradiating the tissue or a photoactivatable composition for up to about 30 minutes, for about 1 to about 30 minutes, for about 1 to about 25 minutes, for about 1 to about 20 minutes, for about 1 to about 19 minutes, for about 1 to about 18 minutes, for about 1 to about 17 minutes, for about 1 to about 16 minutes, for about 1 to about 15 minutes, for about 1 to about 14 minutes, for about 1 to about 13 minutes, for about 1 to about 12 minutes, for about 1 to about 11 minutes, for about 1 to about 10 minutes, for about 1 to about 9 minutes, for about 1 to about 8 minutes, for about 1 to about 7 minutes, for about 1 to about 6 minutes, for about 1 to about 5 minutes, for about 1 to about 4 minutes, or for about 1 to about 3 minutes.

152. A device or lamp substantially as herein described with reference to and/or shown in the figures.

153. A method as herein described with reference to and/or shown in the figures.

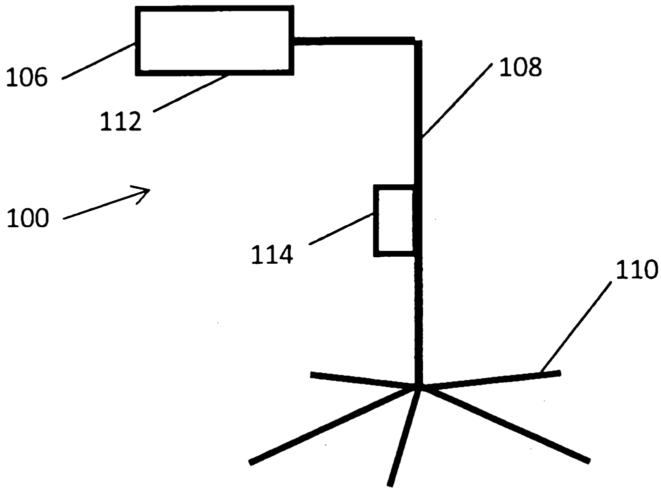


FIG. 1

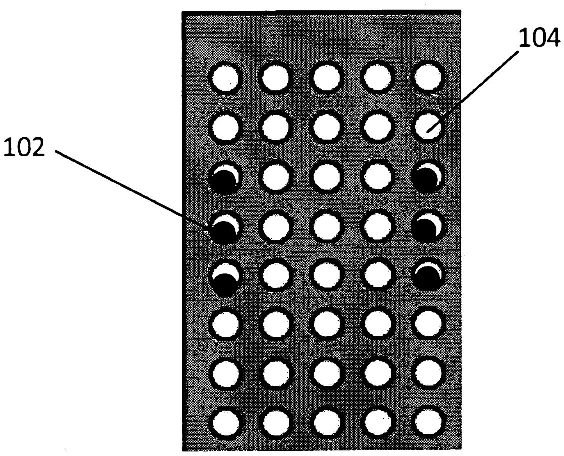


FIG. 2

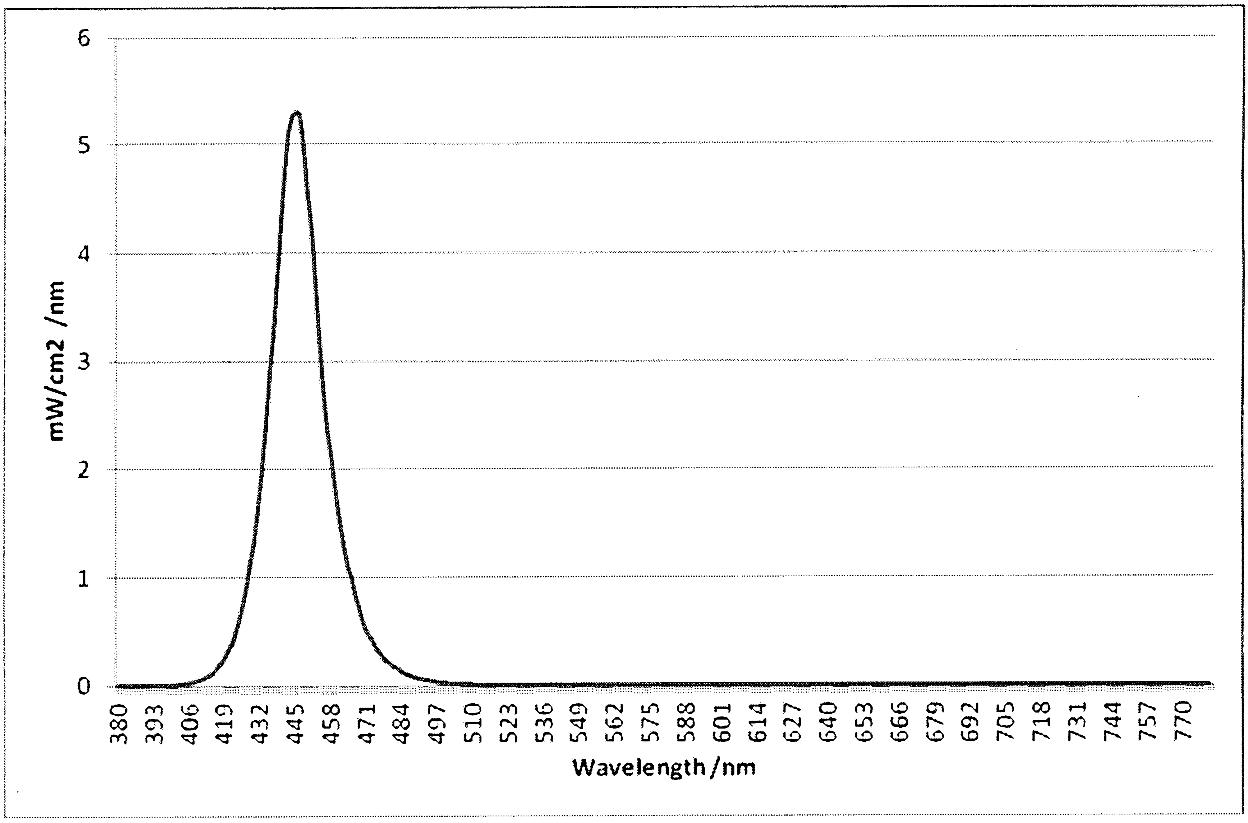

6
5
4
3
2
1
0
mW/cm2 /nm
380
393
406
419
432
445
458
471
484
497
510
523
536
549
562
575
588
601
614
627
640
653
666
679
692
705
718
731
744
757
770
Wavelength /nm

FIG. 3

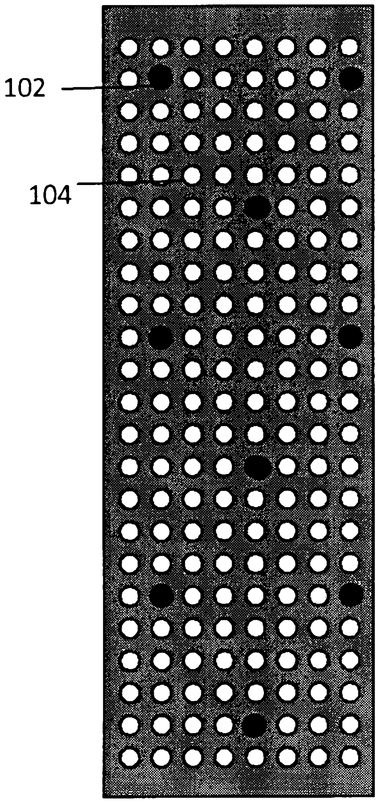


FIG. 4a

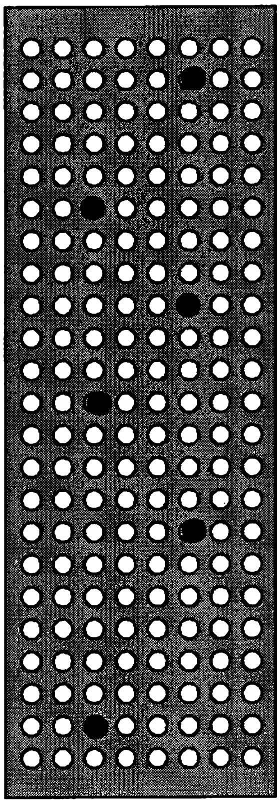


FIG. 4b

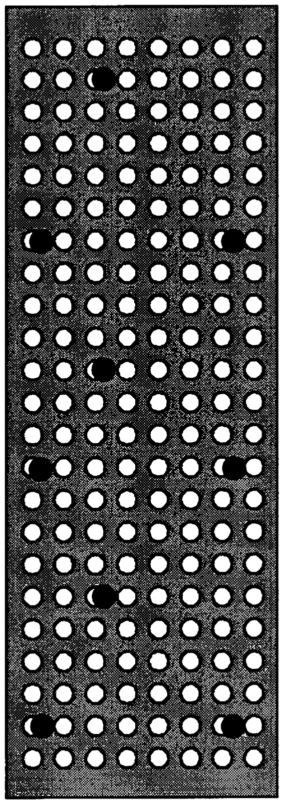


FIG. 4c

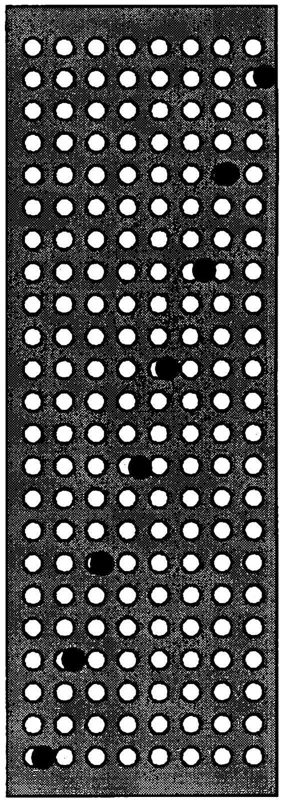


FIG. 4d

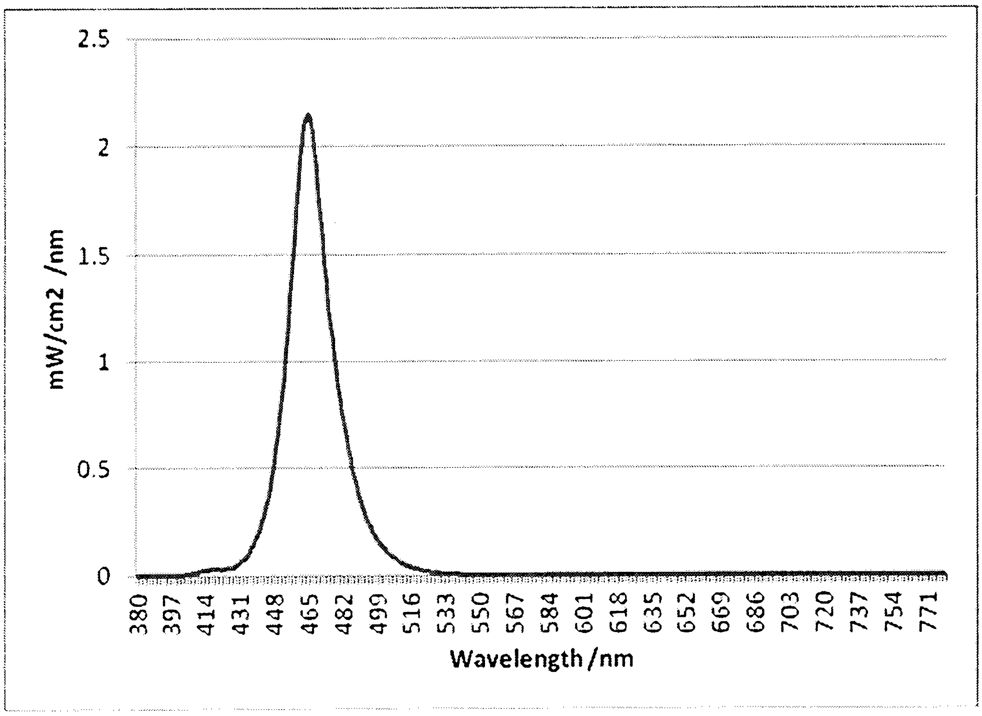


FIG. 5

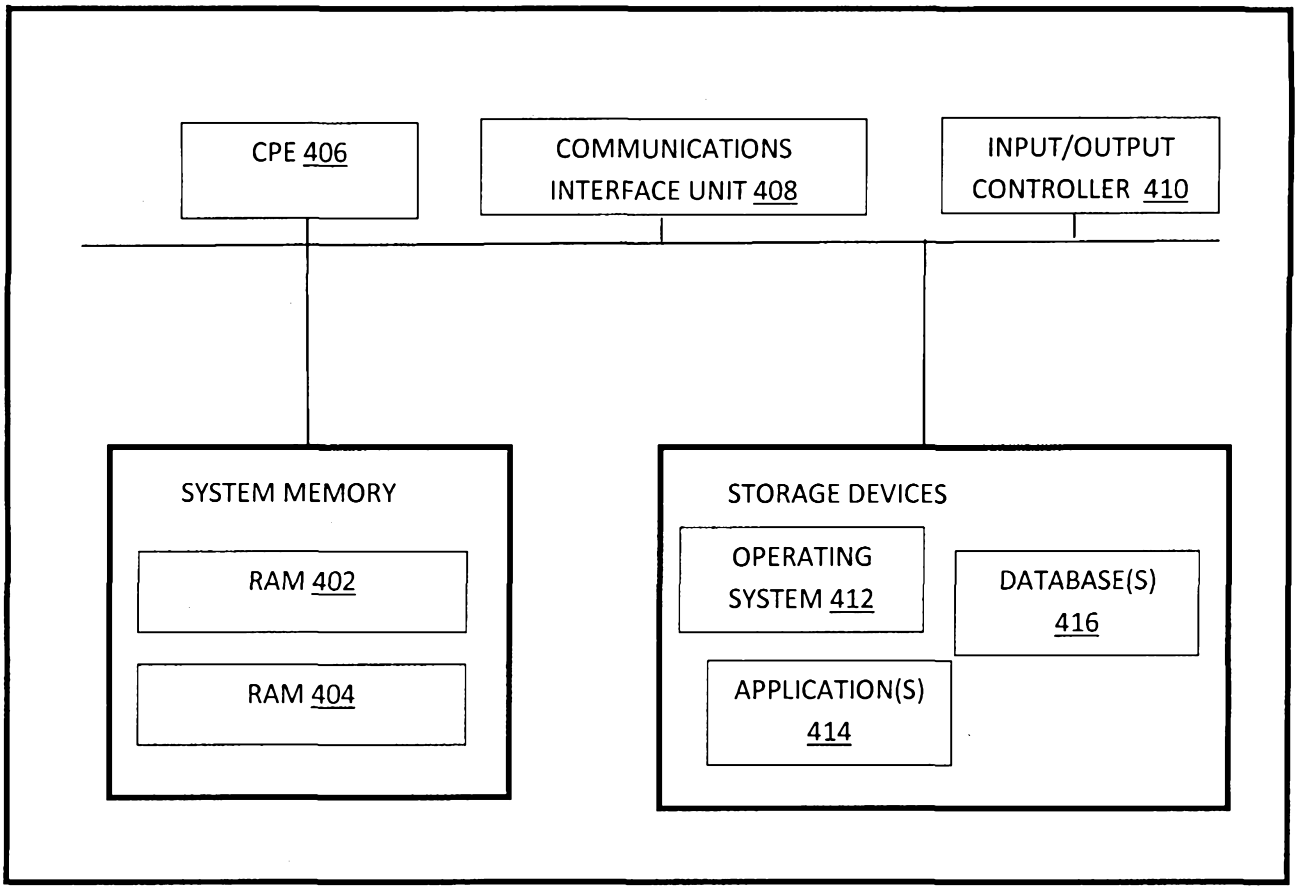

CPE 406
COMMUNICATIONS INTERFACE UNIT 408
INPUT/OUTPUT CONTROLLER 410
SYSTEM MEMORY
RAM 402
RAM 404
STORAGE DEVICES
OPERATING SYSTEM 412
DATABASE(S) 416
APPLICATION(S) 414

FIG. 6

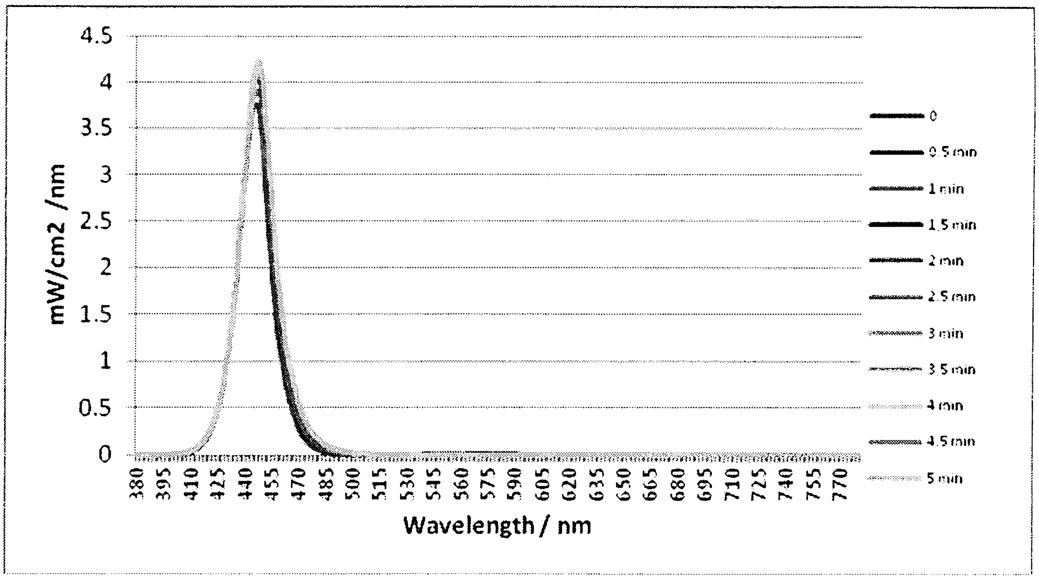

mW/cm2 /nm
Wavelength / nm
0
0.5 min
1 min
1.5 min
2 min
2.5 min
3 min
3.5 min
4 min
4.5 min
5 min

FIG. 7a

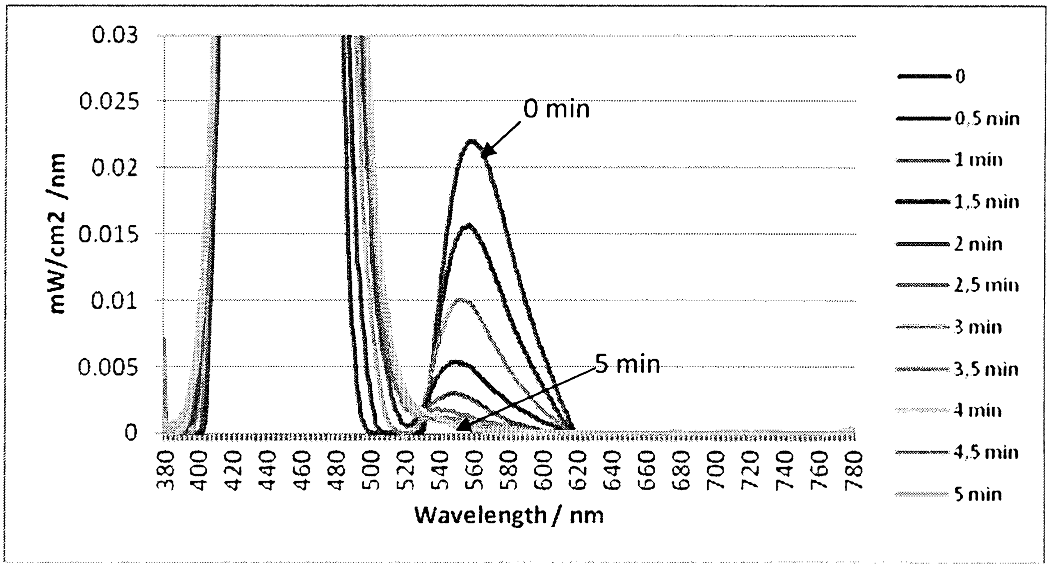

mW/cm2 /nm
Wavelength / nm
0 min
5 min
0
0.5 min
1 min
1.5 min
2 min
2.5 min
3 min
3.5 min
4 min
4.5 min
5 min

FIG. 7b

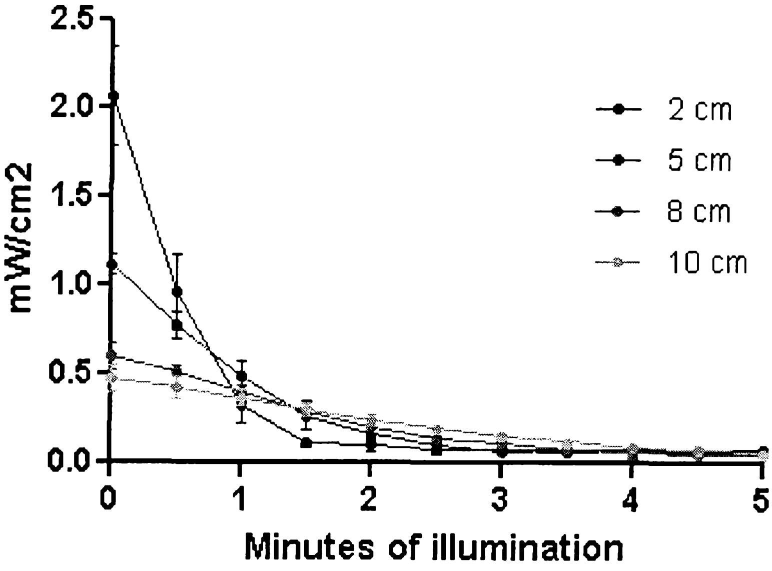

2.5
2.0
1.5
1.0
0.5
0.0
mW/cm2
0
1
2
3
4
5
Minutes of illumination
2 cm
5 cm
8 cm
10 cm

FIG. 8

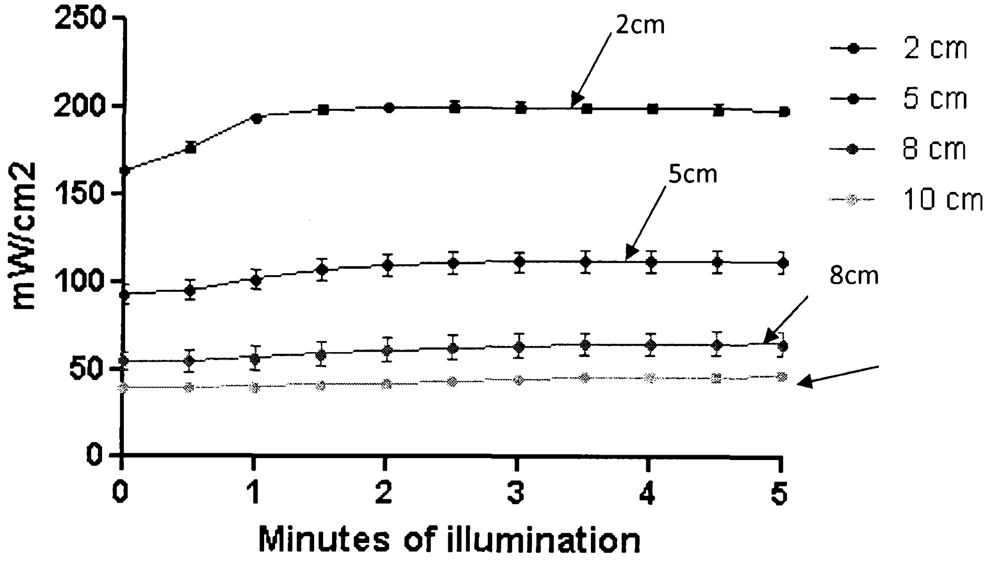
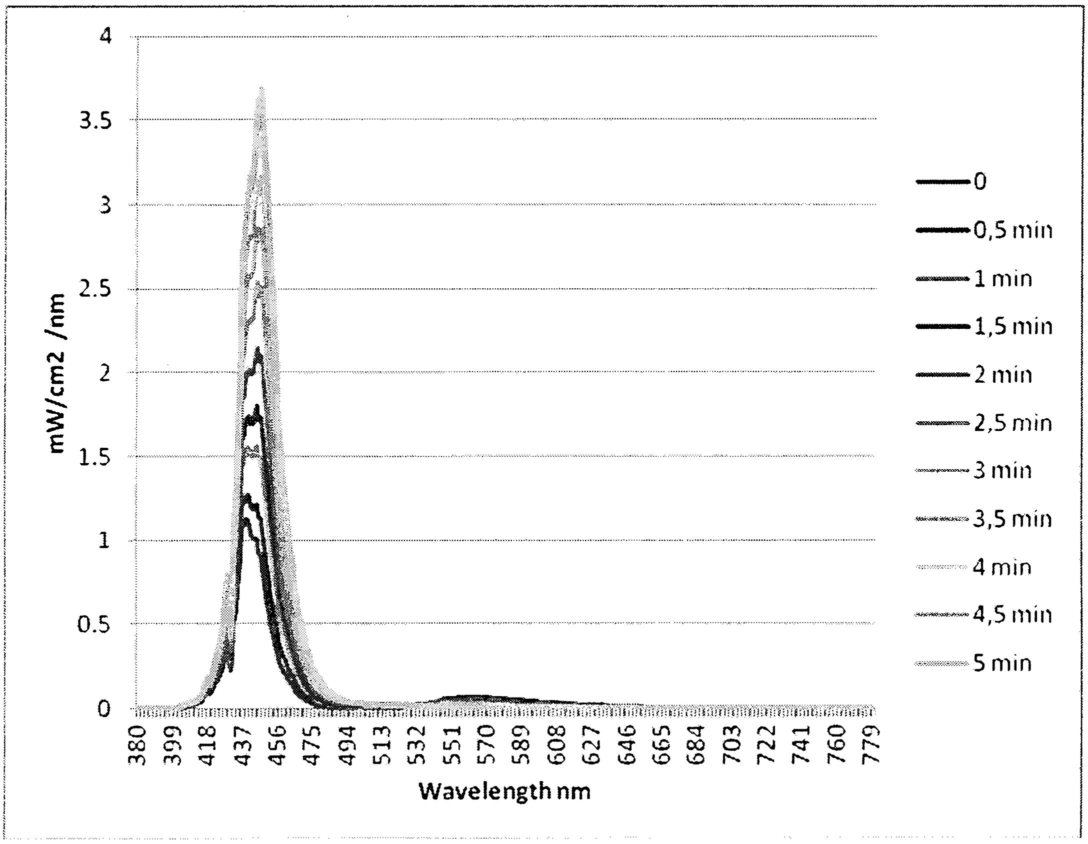

250
200
150
100
50
0
mW/cm2
0
1
2
3
4
5
Minutes of illumination
2cm
5cm
8cm
2 cm
5 cm
8 cm
10 cm

FIG. 9



4
3.5
3
2.5
2
1.5
1
0.5
0
mW/cm2 /nm
380
399
418
437
456
475
494
513
532
551
570
589
608
627
646
665
684
703
722
741
760
779
Wavelength nm
0
0,5 min
1 min
1,5 min
2 min
2,5 min
3 min
3,5 min
4 min
4,5 min
5 min

FIG. 10a

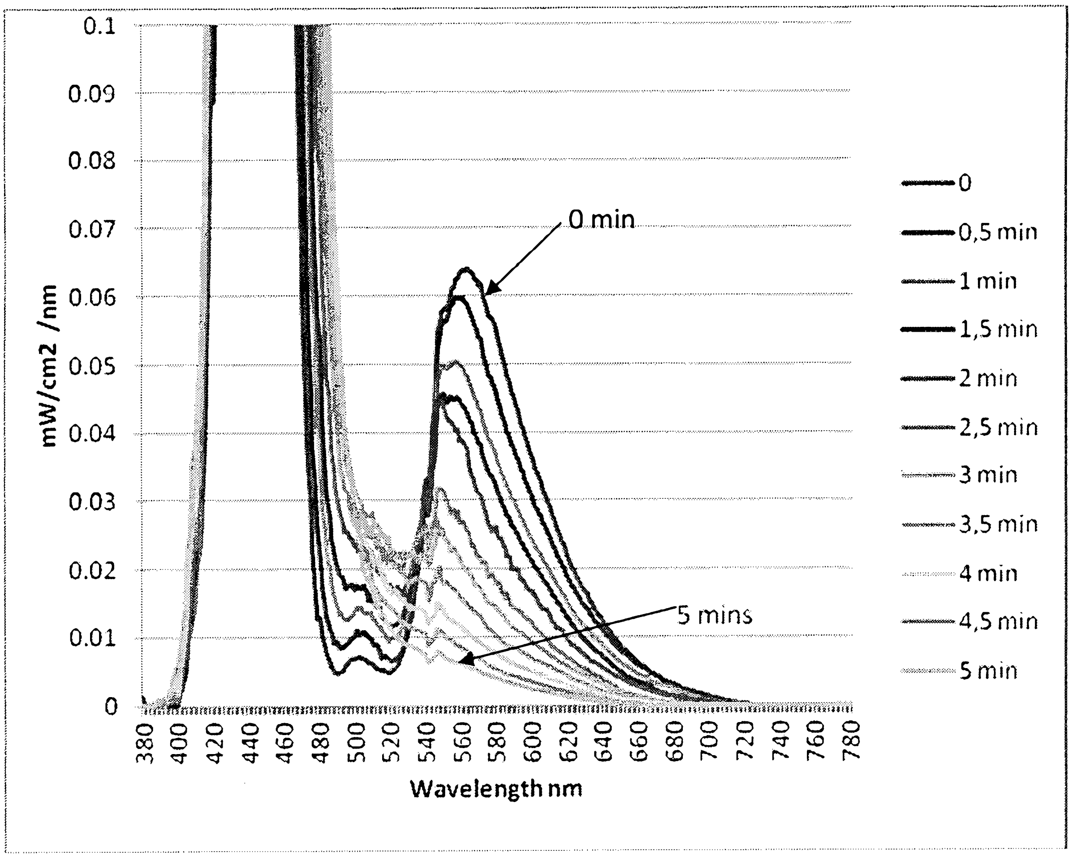

0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
mW/cm2 /nm
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
740
760
780
Wavelength nm
0 min
5 mins
0
0,5 min
1 min
1,5 min
2 min
2,5 min
3 min
3,5 min
4 min
4,5 min
5 min

FIG. 10b

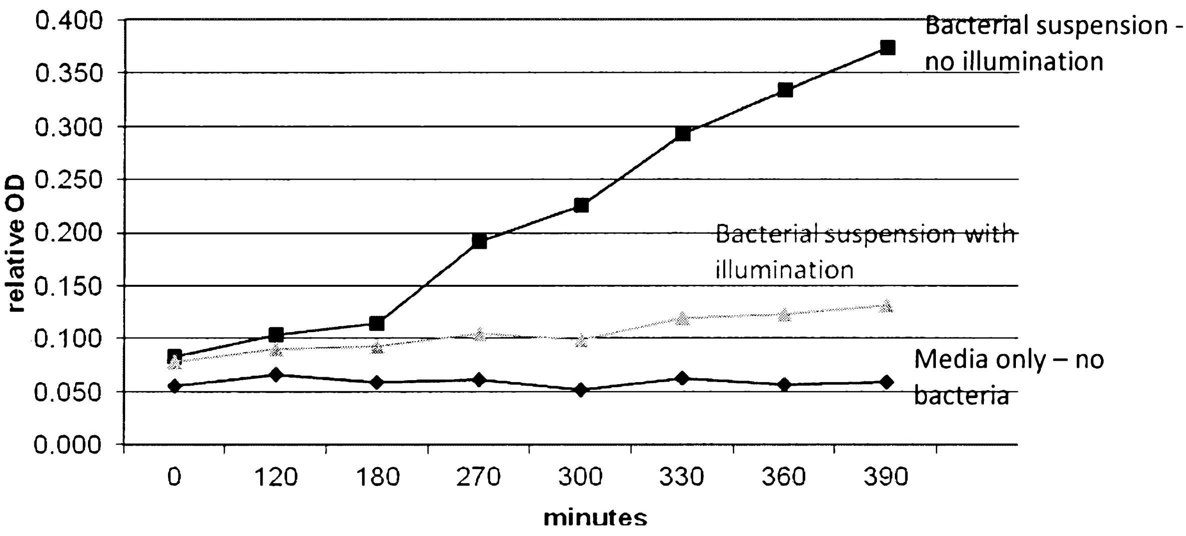


FIG. 11a

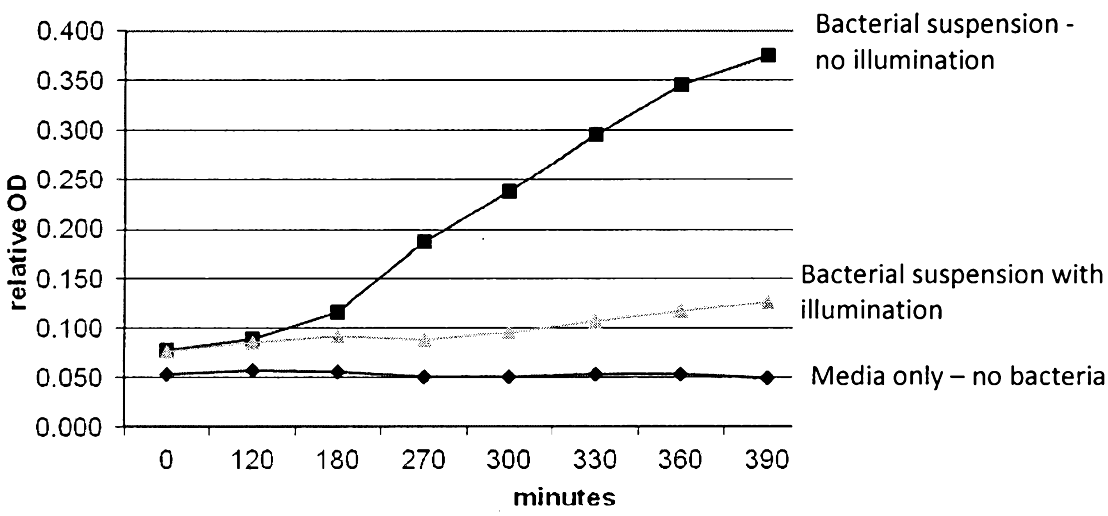


FIG. 11b