photons, have an endogenous bacteria killing effect although the depth to which the photons penetrate into the tissue is smaller than for the low energy photos.

Thus, the same target area can be activated through photon up-conversion reactions where two or more photons are simultaneously absorbed and cause the target molecule(s) to excite to a higher energy state.

In one aspect, the present disclosure provides a non-therapeutic method of treating biological surfaces with electromagnetic radiation in the form of light of two different energy levels, a first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.4 eV to 1.6 eV, wherein photons of the first light and the second light are simultaneously directed against the biological surface.

In another aspect, the present disclosure provides a use of electromagnetic radiation in the manufacture of a medicament for an antimicrobial or antiviral or antifungal therapy on a biological surface of the subject, wherein the electromagnetic radiation in the form of light of two different energy levels, a first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.44 eV to 1.6 eV, wherein photons of the first light and the second light are to be simultaneously directed against the surface.

In yet another aspect, the present disclosure provides a use of electromagnetic radiation in the manufacture of a first medicament and use of at least one photo-sensitive substance in the manufacture of a second medicament, wherein the first and second medicaments are to be used in combination in photodynamic therapy for treating a biological surface of the subject, wherein the electromagnetic radiation in the form of light of two different energy levels, a first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.4 eV to 1.6 eV, wherein photons of the first light and the second light are to be simultaneously directed against the surface.

In another aspect, the present disclosure provides the use of a sensitizer in the manufacture of a medicament for the topical treatment of an infection on a mammal, wherein said

sensitizer is to be applied to a part of skin or mucous membrane and said part is to be subsequently or simultaneously subjected to first photons with a majority energy between 2.95 eV and 3.17 eV; and second photons with a majority energy between 1.4 eV and 1.6 eV.

In one example, a method is provided wherein the target area is contacted with a photosensitizer and then the target area thus treated will be subjected to the combination of first photons having a majority energy between 1.24 eV and 1.65 eV and second photons having a majority energy between 2.8 eV and 3.5 eV, said first and said second photons making up a majority, preferably more than 90 %, of all photons directed towards the target area.

A further example provides a photosensitizer for use in the topical treatment of an infection on a mammal, wherein said sensitizer is applied to a part of skin or mucous membrane and that part is subsequently or simultaneously subjected to first photons with a majority energy between 2.8 eV and 3.5 eV; and second photons with a majority energy between 1.24 eV and 1.65 eV.

In one example, a photosensitizer is provide for use in topical treatment of an infection on a mammal, wherein said sensitizer is first applied to a part of the skin or mucous membrane and that part is subsequently or simultaneously subjected to photons with a majority energy between 3.17 eV and 2.95 eV and 1.56 eV and 1.45 eV, respectively. Such energy levels correspond to wave lengths of about 390 to 420 nm and 795 to 855 nm, respectively.

A still further aspect provides a kit for treatment of microbial, viral or fungal infections of tissue, in biofilm, saliva, skin, plaque, on teeth surfaces and in mucous membranes, comprising an optoelectronic component and device thereof capable of simultaneously emitting a first light consisting of high energy photons having majority energy between 3.17 eV to 2.95 eV and a second light consisting of low energy photons having a majority energy in the range from 1.4 eV to 1.6 eV, said first and said second light amounting to at least 80 % of all light emitted from the optoelectronic component or device, and at least one photosensitizer which can be activated by at least either of the high energy and low energy photons, wherein the photosensitizer is Indocyanine green.

In yet another aspect, the present disclosure provides a kit comprising an optoelectronic device capable of simultaneously emitting high energy photons with majority energy between 2.95 eV and 3.17 eV and low energy photons with majority energy between 1.4 eV and 1.6 eV, together with Indocyaninen green as photosensitizer, capable of carrying out a method for achieving a sustained antimicrobial effect in preventive and curative dental/oral care for long term use.

In yet another aspect, the present disclosure provides a kit comprising an optoelectronic device having a light emitting component that has two or more light emitting surfaces (EPIs), optionally together with Indocyaninen green as a photosensitizer, capable of carrying out a method for achieving a sustained antimicrobial effect in preventive and curative dental/oral care for long term use.

More specifically, the present disclosure is characterized by what is stated in the independent claims.

Considerable advantages are obtained. The use of high and low energy photons to target endo- and exogenous molecules gives rise to a target molecule site specific treatment due to low life-time of reactive or high energized oxygen.

According to the disclosure the high energy photons are being absorbed by endogenous (intracellular) molecules to generate reactive oxygen singlets and reactive oxygen. Simultaneously low energy photons are being absorbed exogenously (extracellular) by the photo-sensitizer resulting in reactive oxygen singlets and reactive oxygen. The reactive oxygen singlets and reactive oxygen species will inactivate, kill and otherwise reduce micro-organisms such as bacteria, virus and fungus in tissue, biofilm, saliva, skin, plaque and teeth surface.

The treatment will achieve good tissue penetration. It makes it possible to give antibacterial treatment to different areas of pathogen at the same time as two or more different energy photons can target molecules in different areas. Different energy photons have also different tissue therapeutic and tissue stimulating effects. The combined high and low energy photons can affect bacterial communication as they might have deleterious effect in bacteriophages, which contain genetic material or other molecules. The light may also have effects in the production, formation or activating of such communicating molecules assessed as quorum sensing.

Claims

1. A non-therapeutic method of treating biological surfaces with electromagnetic radiation in the form of light of two different energy levels, a first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.4 eV to 1.6 eV, wherein photons of the first light and the second light are simultaneously directed against the biological surface.

2. The method according to claim 1, wherein

- non-coherent radiant light energy is generated at at least two different energy levels, a first and a second energy level;
- from the non-coherent radiant light energy there is provided first light having a wavelength corresponding to the majority energy of the first energy level, and second light having a wavelength corresponding to the majority energy of the second energy level; and
- the first and second light are then simultaneously directed against the biological surface.

3. The method according to claim 1 or 2, wherein the biological material of the surface is subjected to endogenous and exogenous excitement, in particular so as to generate reactive oxygen singlets or reactive oxygen species or both.

4. The method according to any of the preceding claims, comprising preventing or combatting biological contamination of surfaces, such as microbial or viral or fungal contamination of biological tissues.

5. The method according to any of the preceding claims, wherein the method is a cosmetic treatment.

6. The method according to any of the preceding claims, wherein the high energy photons and low energy photons are applied in conjugation with at least one exogeneous photo-sensitizer, which can be activated with the low energy photons.

7. The method according to any of the preceding claims, wherein a photosensitizer is provided for use in topical treatment of mammal tissues, wherein said sensitizer is to be applied to a superficial part of the tissue, such as on mammal skin or on a mucous membrane and the part thus treated is to be subsequently or simultaneously subjected to light at two different wavelengths.

8 The method according to any of the preceding claims, wherein a photo-sensitizer is to be contacted with micro-organisms, such as bacteria, virus and fungus, in a target, such as tissue, in biofilm, saliva, skin, plaque and on teeth surfaces or mucous membranes, and wherein the photo-sensitizer is to be applied on the target in the form of an aqueous solution, an alcohol containing solution, a hydrophilic gel, a hydrophobic gel, a hydrophilic polymer, a hydrophobic polymer or a paste, lotion, tape, tablet, plaster or band-aid.

9. The method according to any of the preceding claims, wherein the biological surface is selected from tissues, biofilms, saliva, skin, plaque and teeth surfaces and mucous membranes.

10. The method according to any of the preceding claims, wherein high energy photons absorbed by endogenous molecules and low energy photons absorbed by exogenous molecules are simultaneously emitted from an optoelectronic component or device.

11. The method according to any of the preceding claims, comprising emitting high energy and low energy photons using feed-in voltage or current that is alternated or pulsed at 1Hz to 1 GHz frequency independently from each other.

12. The method according to any of the preceding claims, comprising using an optoelectronic device which includes an optional detector, such as a photo detector, to detect photo luminescence of the endogenous and exogenous molecules or their photo decomposition side products.

13. The method according to any of the preceding claims, comprising using an optoelectronic device having a plurality of semiconductor chips that are connected in series or in parallel, the chips exhibiting emission energy that can be varied in the range of 2.48eV and 1.24 eV and in the range of 3.5eV and 2.8 eV, respectively.

14. The method according to any of the preceding claims, comprising using during a first period of time a first photosensitizer and during a second period of time a second photosensitizer, which is different from the first photosensitizer.

15. The method according to claim 13 or 14, wherein the first photosensitizer and the second photosensitizer are activated using first light and second light, respectively.

16. The method according to any of claims 13 to 15, wherein the first photosensitizers are used in combination, or alternatingly, or at least one of them is used at a predetermined point of time during the treatment.

17. The method according to any of the preceding claims, wherein the photosensitizer(s) is(are) selected from the group of natural compounds comprising hypericin, curcumin, Cercosporin, psoralen, xanthotoxin, Angelicin, alpha-Terthienyl, Phenylthepatriyne, THC, Cannabidiol (CBD) and combinations thereof, and the group of synthetic photosensitizers comprising RB (Rose Bengal), MB, , Methylene Blue, Indocyanine Green, Erythosine, and combinations thereof, or at least one photosensitizer is selected from the group of natural compounds listed above, and at least one photosensitizer is selected from the group of synthetic compounds listed above.

18. The method according to any of the preceding claims, wherein light energy, in particular non-coherent radiant light energy, is directed towards the biological surface at a first wavelength from 400 to 430 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min, and at a second wavelength from 780 to 830 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min.

19. The method according to any of the preceding claims, wherein the light is produced by one or several light-emitting diodes.

20. Use of electromagnetic radiation in the manufacture of a medicament for an antimicrobial or antiviral or antifungal therapy on a biological surface of the subject, wherein the electromagnetic radiation in the form of light of two different energy levels, a

first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.44 eV to 1.6 eV, wherein photons of the first light and the second light are to be simultaneously directed against the surface.

21. Use of electromagnetic radiation in the manufacture of a first medicament and use of at least one photo-sensitive substance in the manufacture of a second medicament, wherein the first and second medicaments are to be used in combination in photodynamic therapy for treating a biological surface of the subject, wherein the electromagnetic radiation in the form of light of two different energy levels, a first light with photons having a majority energy in the range from 3.17 eV to 2.95 eV and a second light with photons having a majority energy in the range from 1.4 eV to 1.6 eV, wherein photons of the first light and the second light are to be simultaneously directed against the surface.

22. Use of a sensitizer in the manufacture of a medicament for the topical treatment of an infection on a mammal, wherein said sensitizer is to be applied to a part of skin or mucous membrane and said part is to be subsequently or simultaneously subjected to first photons with a majority energy between 2.95 eV and 3.17 eV; and second photons with a majority energy between 1.4 eV and 1.6 eV.

23. The use according to claim 22, wherein the infection is a microbial, viral or fungal infection of tissue, in biofilm, saliva, skin, plaque, on teeth surfaces and mucous membrane.

24. The use according to any of the claims 20 or 23, comprising at least one photosensitizer selected from the group of natural compounds comprising hypericin, curcumin, , Cercosporin, psoralen, xanthotoxin, Angelicin, alpha-Terthienyl, Phenylthepatriyne, THC, Cannabidiol (CBD) and combinations thereof, and the group of synthetic photosensitizers comprising RB (Rose Bengal), MB, , Methylene Blue, Indocyanine Green, Erythosine, resveratrol, berry extracts, such as lingonberry and blueberry including polyphenolic compounds and/or anthocyanine compounds and combinations thereof, or the photosensitizer being the combination of at least one photosensitizer is selected from the group of natural compounds listed above and at least one photosensitizer is selected from the group of synthetic compounds listed above.

25. The use according to any of claims 22 to 24, wherein the photosensitizer is subjected to light energy, in particular non-coherent radiant light energy, at a first wavelength from 400 to 430 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min, and at a second wavelength from 780 to 830 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min.

26. The use according to any of the claims 22 to 25 wherein the part of skin or mucous membrane comprises a biofilm formed by *Streptococcus mutans*.

27. A kit for treatment of microbial, viral or fungal infections of tissue, in biofilm, saliva, skin, plaque, on teeth surfaces and in mucous membranes, comprising an optoelectronic device capable of simultaneously emitting a first light consisting of high energy photons having majority energy between 3.17 eV to 2.95 eV and a second light consisting of low energy photons having a majority energy in the range from 1.4 eV to 1.6 eV, said first and said second light amounting to at least 80 % of all light emitted from the optoelectronic component or device, and at least one photosensitizer which can be activated by at least either of the high energy and low energy photons, wherein the photosensitizer is Indocyanine green.

28. A kit comprising an optoelectronic device capable of simultaneously emitting high energy photons with majority energy between 2.95 eV and 3.17 eV and low energy photons with majority energy between 1.4 eV and 1.6 eV, together with Indocyaninen green as photosensitizer, capable of carrying out a method for achieving a sustained antimicrobial effect in preventive and curative dental/oral care for long term use.

29. A kit according to claim 28 comprising an optoelectronic device having a light emitting component that has two or more light emitting surfaces (EPIs), optionally together with Indocyaninen green as a photosensitizer, capable of carrying out a method for achieving a sustained antimicrobial effect in preventive and curative dental/oral care for long term use.

30. A kit according to any of claims 27 to 29, further comprising a sensor capable of monitoring treatment progression, said sensor in particular being capable of detecting

treatment progression and of producing a regulation signal based on the progress of the treatment, said sensor being coupled to the optoelectronic device do adjust the light emitted from the optoelectronic device depending on the regulation signal.

31. A kit according to any of claims 27 to 30, comprising an optoelectronic device exhibiting the shape of a tooth brush, or the shape of a mouth piece which can be inserted in a mouth between the biting surfaces of the teeth, or the shape of a rod like illuminator.

32. The kit according to any of claims 27 to 31, wherein the optoelectronic device used comprises micro-spectrometer sensors, temperature sensors, light sensors, pH sensors, force sensors, gyroscopes, pressure sensors or combinations thereof.

33. The kit according to any of claims 27 to 32, comprising a tooth whitening substance capable of being used with a dual wavelength light source or together with a photosensitizer.

34. The kit according to any of claims 27 to 33, comprising a photosensitizer in form of water soluble effervescent tablet and further comprising a hand held light applicator capable of emitting dual light photons.

35. The kit according to any of claims 27 to 34, comprising a photosensitizer in the form of a water soluble effervescent tablet, gel, or paste, and further comprising a one-time use mouth piece and light applicator.

36. The kit according to any of claims 27 to 35, comprising a photosensitizer in the form of photosensitizers incorporated or inherently present in berry extracted mouth rinse.

37. The kit according to any of claims 27 to 36, comprising hydrogen peroxide as a potentiating compound.

38. The kit according to any of claims 27 to 37, wherein the optoelectronic device is capable of emitting light, in particular non-coherent light, at a first wavelength from 400 to 430 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min, and at a second

wavelength from 780 to 830 nm, preferably at a dosage of 1 to 120 J/cm^2, and in particular with a power density of from 10 to 2500 mW/cm^2 for a period of time from 0.5 s to 120 min.

39. The kit according to any of claims 27 to 38, wherein the optoelectronic device comprising light-emitting diode(s) as a light source.