

CLAIMS

1. A non-invasive system for determining a physiological parameter in a bodily fluid of a subject comprising:

(a) a radiation source adapted ~~for emitting visible~~ to emit visible (VIS)/near-infrared (NIR) radiation in the range of ~~about 400 nm to about 1500 nm or 500 nm to about 1500 nm~~ into a body part of said subject,

wherein the body part is particularly selected from a fingertip, an ear lobe, a wrist, a forearm, and upper arm,

and wherein the irradiated body part absorbs the emitted electromagnetic energy resulting in a local increase of tissue temperature and in an increased emission of IR radiation in the wavelength range of about 5 μ m to about 12 μ m,

(b) a sensing unit ~~for detecting~~ adapted to detect emitted IR radiation from the previously irradiated body part of said subject in the range of ~~about 5 μ m to about 12 μ m,~~

wherein said sensing unit is adapted ~~for~~ to (i) ~~detecting~~ detect IR radiation having at least one first wavelength or first wavelength range where the intensity of the ~~detected IR radiation~~ parameter is dependent from the concentration of the physiological parameter in the bodily fluid of said subject, and for (ii) ~~detecting IR radiation having at least one wavelength or wavelength range where the intensity of the detected IR radiation is substantially independent from the concentration of the physiological parameter in the bodily fluid of said subject,~~ and to (ii) detect IR radiation having at least one second wavelength or second wavelength range where the intensity of the detected IR radiation is substantially independent from the concentration of the physiological parameter in the bodily fluid of said subject,

wherein the at least one first wavelength or first wavelength range and the at least one second wavelength or second wavelength range are within the wavelength range of 5 μ m to 12 μ m and

- _____ (c) an analyzing unit ~~for~~configured to perform the qualitative and/or quantitative determination of the physiological parameter based on the IR radiation detected in the sensing unit (b). in the at least one first wavelength or first wavelength range and the at least one second wavelength or second wavelength range.
2. The system of claim 1, which does not comprise an external radiation source ~~for emitting~~adapted to emit IR radiation in the wavelength range of ~~about 5~~ μm to ~~about 12~~ μm .
3. The system of claim 1 or 2, wherein the physiological parameter is glucose and the bodily fluid is ~~glucose~~.blood.
4. ~~The system of any one of the preceding claims which is adapted for determining glucose in blood,~~ wherein said sensing unit is particularly adapted for detecting to detect IR radiation having at least one first wavelength or first wavelength range where the intensity of the detected IR radiation is dependent from the concentration of glucose in the blood of said subject,
wherein said at least one first wavelength or first wavelength range is more particularly selected from a wavelength of about 9.2 μm , a wavelength of about 9.4 μm , a wavelength of about 9.6 μm , a wavelength range comprising at least two of the wavelengths of about 9.2 μm , about 9.4 μm and about 9.6 μm , a wavelength range comprising the wavelengths of about 9.2 μm , about 9.4 μm and about 9.6 μm or any combination thereof.
54. The system of any one of the preceding claims, wherein the radiation source (a) is adapted ~~for emitting~~to emit VIS/NIR radiation in the range of ~~about 550~~ nm to ~~about 1200~~ nm, particularly in the range of ~~about 800~~ nm to ~~about 820~~ nm, e.g., at about 810 nm, and/or in the range of ~~about 590~~ nm to ~~about 610~~ nm, e.g., at about 600 nm, and/or in the range of ~~about 920~~ nm to ~~about 980~~ nm, e.g., at about 940 nm.

65. The system of any one of the preceding claims, wherein the radiation source (a) is a LED, a laser diode, a vcsel (vertical-cavity surface-emitting laser) or a laser, and/or wherein the radiation source (a) is a multi-wavelength radiation source.
- ~~7. The system of any one of the preceding claims, wherein the radiation source (a) is a multi-wavelength radiation source.~~
86. The system of claim any one of the preceding claims, wherein the sensing unit (b) comprises at least one first sensor, at least one second sensor, and optionally at least one third sensor,
wherein the at least one first sensor is adapted ~~for detecting~~to detect IR radiation having at least one first wavelength or first wavelength range where the intensity of the detected IR radiation is dependent from the concentration of the physiological parameter in the bodily fluid of said subject,
wherein the at least one second sensor is adapted ~~for detecting~~to detect IR radiation having at least one second wavelength or second wavelength range where the intensity of the detected IR radiation is substantially independent from the concentration of the physiological parameter in the bodily fluid of said subject, and
wherein the at least one third sensor, if present, (i) is adapted ~~for detecting~~to detect unspecific IR radiation, (ii) is adapted ~~for detecting~~to detect unspecific VIS/NIR radiation, (iii) is adapted ~~for detecting~~to detect VIS/NIR radiation having a wavelength, where the intensity of the detected VIS/NIR radiation is dependent from the concentration of the physiological parameter in the bodily fluid of said subject, and/or (iv) is a temperature sensor ~~for measuring~~adapted to measure the temperature of the body part.
97. The system of claim 86, wherein at least one first sensor is adapted ~~for detecting~~to detect IR radiation having a first wavelength or wavelength range and at least one other first sensor is adapted ~~for detecting~~to detect IR radiation having a second wavelength range,

wherein the second wavelength range comprises the first wavelength or wavelength range and further comprises another wavelength or wavelength range,

wherein the system is particularly adapted for determining glucose in blood, wherein a first sensor is adapted ~~for detecting~~to detect IR radiation having a wavelength of about 9.2 μm and another first sensor is adapted ~~for detecting~~to detect IR radiation having a wavelength range between ~~about~~ 9.2 μm and ~~about~~ 9.6 μm which comprises the first wavelength of about 9.2 μm and further comprises at least one wavelength of about 9.4 μm and about 9.6 μm , and particularly further comprises a wavelength of about 9.4 μm and about 9.6 μm .

108. The system of claim ~~86~~ or ~~97~~ comprising at least two different second sensors, which are adapted ~~for detecting~~to detect IR radiation having at least two different wavelengths or wavelength ranges,

wherein the system is particularly adapted ~~for determining~~to determine glucose in blood, wherein a second sensor is adapted ~~for detecting~~to detect IR radiation having a wavelength or wavelength range between ~~about~~ 8.6 μm and 9.0 μm and another second sensor is adapted ~~for detecting~~to detect IR radiation having a wavelength or wavelength range between ~~about~~ 9.8 μm and ~~about~~ 10.2 μm .

119. The system of any of the preceding claims, wherein the sensing unit (b) comprises at least one sensor adapted ~~for~~to time-dependently and separately ~~detecting~~detect IR radiation having different wavelengths or wavelength ranges,

wherein in at least one first time interval the sensor is adapted ~~for detecting~~to detect IR radiation having at least one wavelength or wavelength range where the intensity of the detected IR radiation is dependent from the concentration of the physiological parameter in the bodily fluid of said subject, and

wherein in at least one second time interval the sensor is adapted ~~for detecting~~to detect IR radiation having at least one wavelength or wavelength range where the intensity of the detected IR radiation is substantially

independent from the concentration of the physiological parameter in the bodily fluid of said subject.

~~12~~10. The system of any one of the preceding claims, wherein the sensing unit (b) comprises a single sensor, and/or

~~13.~~ The system of any one of the preceding claims, wherein the sensing unit (b) comprises at least one sensor which is an optical detector, particularly an optical photovoltaics detector, more particularly an InAsSb-based detector.

~~14~~11. The system of any one of the preceding claims further comprising a cover, wherein said cover is at least partially made of a material which is optically transparent for IR/VIS radiation emitted by the radiation source (a) and for IR radiation detected by the sensing unit (b), wherein the cover is at least partially made of CaF₂ and/or BaF₂ and and/or of a plastic material which is transparent for IR radiation and optionally transparent for VIS/NIR radiation, wherein the optically transparent material of the cover has a thickness of about 0.2 mm to about 2 mm, particularly of about 0.5 mm to about 1.5 mm, more particularly about 1 mm, and/or

~~15.~~ The system of any one of the preceding claims further comprising a cover which focuses IR radiation from the body part to the sensing unit (b), particularly to the at least one sensor of the sensing unit (b), particularly wherein the cover comprises an IR Fresnel lens or an array comprising a plurality of IR Fresnel lenses.

~~16~~12. Use of the system of any one of the preceding claims for non-invasively determining a physiological parameter in a bodily fluid of a subject, wherein the physiological parameter is glucose, and the bodily fluid is blood, and wherein the alteration rate of the amount of glucose in blood is determined.

~~17~~13. A method for non-invasively determining a physiological parameter in a bodily fluid of a subject comprising the steps:

(a) irradiating a body part of said subject with ~~visual~~visible (VIS)/near-infrared (NIR) radiation in the wavelength range of ~~about~~ 400 nm to ~~about~~ 1500 nm, or ~~about~~ 500 nm to ~~about~~ 1500 nm, wherein the irradiated body part absorbs the emitted electromagnetic energy resulting in a local increase of tissue temperature and in an increased emission of IR radiation in the wavelength range of ~~about~~ 5 μ m to ~~about~~ 12 μ m,

(b) detecting emitted IR radiation from the previously irradiated body part of said subject in the wavelength range of ~~about~~ 5 μ m to ~~about~~ 12 μ m,

comprising separately (i) detecting IR radiation having at least one wavelength or wavelength range where the intensity of the detected IR radiation is dependent from the concentration of the physiological parameter in the bodily fluid of said subject, and

(ii) detecting IR radiation having at least one wavelength or wavelength range where the intensity of the detected IR radiation is substantially independent from the concentration of the physiological parameter in the bodily fluid of said subject, and

(c) analyzing the detected IR radiation for the qualitative and/or quantitative determination of the physiological parameter.

~~18. The method of claim 17, wherein the body part is not irradiated with an external source of IR radiation in the wavelength range of about 5 μ m to about 12 μ m.~~

~~19. The method of claim 17 or 18, wherein the physiological parameter is glucose and the bodily fluid is blood.~~

~~20. The method of any one of claims 17-19, particularly wherein the concentration of the physiological parameter is quantitatively determined,~~

and/or wherein the alteration rate of the amount of the physiological parameter is determined, particularly non-quantitatively determined.

14. The method of claim 13, wherein the body part is not irradiated with an external source of IR radiation in the wavelength range of 5 μm to 12 μm .

15. The method of claim 13 or 14, wherein the physiological parameter is glucose, and the bodily fluid is blood.