CLAIMS

1. An optical arrangement comprising:

a first fiber optic probe configured to measure Raman spectra of a skin sample;

a second fiber optic probe configured to measure diffuse reflectance spectra of the skin sample; and

an imaging camera configured to capture a reflectance image of the skin sample,

wherein the first fiber optic probe, at least part of the second fiber optic probe and the imaging camera are arranged adjacent to one another,

the optical arrangement is configured to acquire at least one selected from the Raman spectra, the diffuse reflectance spectra, or the reflectance image in a location of the skin sample, and

based on the at least one selected from the acquired Raman spectra, the acquired diffuse reflectance spectra, or the acquired reflectance image, the optical arrangement is configured to interrogate a pre-determined depth below a surface of the skin sample at the location, or tissue chromophores of the skin sample at the pre-determined depth, or both.

2. The optical arrangement according to Claim 1, where the optical arrangement is configured to acquire a combination of at least two selected from the Raman spectra, the diffuse reflectance spectra, or the reflectance image sequentially in the location of the skin sample; and/or

wherein the first fiber optic probe, the second fiber optic probe and the imaging camera integrally form the optical arrangement in a single probe.

3. The optical arrangement according to Claim 1 or 2, wherein the first fiber optic probe comprises a first optical fiber configured to deliver laser energy to excite the skin sample; and a first plurality of optical fibers configured to detect and measure the Raman spectra of the skin sample.

4. The optical arrangement according to Claim 3,

wherein the first optical fiber is centrally arranged along the first fiber optic probe, and the first plurality of optical fibers is arranged substantially surrounding the first optical fiber; and/or

each optical fiber of the first plurality of optical fibers is arranged adjacent to and spaced apart from a neighbouring optical fiber of the first plurality of optical fibers; and/or

the first optical fiber comprises a first optical fiber bundle, and each optical fiber of the first plurality of optical fibers comprises an optical fiber bundle; and/or

the first optical fiber or each of the first plurality of optical fibers includes a single mode fiber, or a multimode fiber, or a combination of a single mode fiber and a multimode fiber; and/or

the first optical fiber has a core size ranging from 150-800 μm and a cladding size of 160-800 μm; and/or

the first optical fiber has a transmission range of 350 nm to 2400 nm.

5. The optical arrangement according to any one of Claims 1 to 4, wherein the second fiber optic probe comprises a second optical fiber configured to deliver light to the skin sample; and a second plurality of optical fibers configured to detect and measure the diffuse reflectance spectra of the skin sample.

6. The optical arrangement according to Claim 5,

wherein the second optical fiber is centrally arranged along the second fiber optic probe, and the second plurality of optical fibers is arranged substantially surrounding the second optical fiber; and/or

each optical fiber of the second plurality of optical fibers is arranged adjacent to and spaced apart from a neighbouring optical fiber of the second plurality of optical fibers; and/or

the second optical fiber comprises a second optical fiber bundle, and each optical fiber of the second plurality of optical fibers comprises an optical fiber bundle; and/or

the second optical fiber or each of the second plurality of optical fibers includes a single mode fiber, or a multimode fiber, or a combination of a single mode fiber and a multimode fiber; and/or

the second optical fiber has a core size ranging from 150-800 μm and a cladding size of 160-800 μm; and/or

the second optical fiber has a transmission range of 350 nm to 2400 nm.

7. The optical arrangement according to Claim 5 to 6, wherein each optical fiber of the second plurality of optical fibers is arranged at a distance ranging between 2700 μm and 6000 μm from the second optical fiber, the optical arrangement being configured to interrogate the pre-determined depth below the surface of the skin sample ranging between 1300 μm and 3000 μm; or

wherein each optical fiber of the second plurality of optical fibers is arranged at a distance ranging between 500 μm and 1000 μm from the second optical fiber, the optical arrangement being configured to interrogate the pre-determined depth below the surface of the skin sample ranging between 250 μm and 2500 μm; or

wherein the optical arrangement is configured to interrogate the pre-determined depth below the surface of the skin sample ranging between 25 μm and 1 mm.

8. The optical arrangement according to any one of Claims 5 to 7, wherein the first fiber optic probe and the imaging camera are integrated into the second fiber optic probe such that the second plurality of optical fibers is arranged substantially surrounding the second optical fiber, the first fiber optic probe and the imaging camera; and/or

wherein the second fiber optic probe further comprises a third optical fiber configured to deliver the light to the skin sample, the third optical fiber being arranged offset from the second optical fiber and substantially surrounded by the second plurality of optical fibers, preferably the first fiber optic probe and the imaging camera being collectively arranged between the second optical fiber and the third optical fiber.

9. A device comprising:

an analytical unit; and

an optical arrangement in communication with the analytical unit,

wherein

the optical arrangement comprises:

a first fiber optic probe configured to measure Raman spectra of a skin sample;

a second fiber optic probe configured to measure diffuse reflectance spectra of the skin sample; and

an imaging camera configured to capture a reflectance image of the skin sample,

the first fiber optic probe, at least part of the second fiber optic probe and the imaging camera being arranged adjacent to one another,

wherein the optical arrangement is configured to acquire at least one selected from the Raman spectra, the diffuse reflectance spectra, or the reflectance image in a location of the skin sample,

based on the at least one selected from the acquired Raman spectra, the acquired diffuse reflectance spectra, or the acquired reflectance image, the optical arrangement is configured to interrogate a pre-determined depth below a surface of the skin sample at the location, or tissue chromophores of the skin sample at the pre-determined depth, or both, and

wherein the analytical unit is configured to assess data including the at least one selected from the acquired Raman spectra, the acquired diffuse reflectance spectra, or the acquired reflectance image, and the interrogated pre-determined depth and the interrogated tissue chromophores to determine a medical status and/or condition based on the skin sample.

10. The device according to Claim 9, where the optical arrangement is configured to acquire a combination of at least two selected from the Raman spectra, the diffuse reflectance spectra, or the reflectance image sequentially in the location of the skin sample; and/or

wherein the analytical unit comprises:

a receiving unit configured to receive the data;

a processor configured to unmix the interrogated tissue chromophores and determine relative changes of tissue chromophores of the skin sample, wherein the processor is further configured to generate an objective index based on the determined relative changes of tissue chromophores, the objective index being used to monitor an efficacy of a course of treatment on the medical status and/or condition; and

an output unit configured to provide information based on the determined relative changes of tissue chromophores.

11. A non-invasive method for analyzing a skin sample, the non-invasive method comprises:

acquiring at least one selected from Raman spectra, diffuse reflectance spectra or a reflectance image of the skin sample in a location of the skin sample;

based on the at least one selected from the acquired Raman spectra, the acquired diffuse reflectance spectra, and the acquired reflectance image, interrogating a pre-determined depth below a surface of the skin sample at the location, or tissue chromophores of the skin sample at the pre-determined depth, or both; and

assessing data including the at least one selected from the acquired Raman spectra, the acquired diffuse reflectance spectra, or the acquired reflectance image, and the interrogated pre-determined depth and the interrogated tissue chromophores to determine a medical status and/or condition based on the skin sample.

12. The non-invasive method according to Claim 11, wherein acquiring the at least one selected from the Raman spectra, the diffuse reflectance spectra or the reflectance image of the skin sample comprises one of the following:

(i) acquiring a combination of at least two selected from the Raman spectra, the diffuse reflectance spectra or the reflectance image of the skin sample sequentially in the location of the skin sample, preferably comprising at least two correspondingly selected from:

delivering laser energy to excite the skin sample, and sequentially measuring the Raman spectra using a first fiber optic probe;

delivering light to illuminate the skin sample, and sequentially measuring the diffuse reflectance spectra using a second fiber optic probe; or

sequentially capturing the reflectance image using an imaging camera; or

(ii) acquiring the Raman spectra, the diffuse reflectance spectra and the reflectance image of the skin sample sequentially in the location of the skin sample, preferably comprising:

delivering the laser energy to excite the skin sample, and measuring the Raman spectra using the first fiber optic probe;

delivering the light to illuminate the skin sample, and sequentially measuring the diffuse reflectance spectra using the second fiber optic probe; and

sequentially capturing the reflectance image using an imaging camera.

13. The non-invasive method according to Claim 12, wherein the laser energy is emitted from a laser operable in a wavelength range of 500 nm to 950 nm; the laser being a single wavelength laser or a tunable laser; and/or

the light has a wavelength in a range of 300 nm to 2500 nm; and/or

the first fiber optic probe, the second fiber optic probe and the imaging camera form a stable and non-revolving optical collection assemble; and/or

wherein acquiring the combination of the at least two selected from the Raman spectra, the diffuse reflectance spectra or the reflectance image of the skin sample sequentially in the location of the skin sample comprises acquiring the at least two selected from the Raman spectra, the diffuse reflectance spectra or the reflectance image of the skin sample sequentially in less than 1 minute in the location of the skin sample.

14. The non-invasive method according to any one of Claims 11 to 13, wherein each of the Raman spectra, the diffuse reflectance spectra and the reflectance image is polarization-independent, and/or

wherein assessing the data comprises receiving the data, unmixing the interrogated tissue chromophores, determining relative changes of tissue chromophores of the skin sample, and providing information based on the determined relative changes of tissue chromophores, the method further comprising generating an objective index based on the

determined relative changes of tissue chromophores, the objective index being used to monitor an efficacy of a course of treatment on the medical status and/or condition; and/or

the method being performed in substantially real-time to provide continuous monitoring of the medical status and/or condition.

15. The non-invasive method according to any one of Claims 11 to 14, wherein the pre-determined depth is ranged between 25 μm and 1 mm, or between 1300 μm and 3000 μm, or 250 μm and 2500 μm; and/or

wherein the tissue chromophores comprise:

endogenous tissue chromophores, or

at least one of water contents, lipid contents, melanin contents, oxygen saturation levels, estrogen levels, and blood fraction levels; and/or

wherein the skin sample is a vulva/vagina skin sample; and/or

wherein the medical status and/or condition is associated with Genitourinary Syndrome of Menopause of a female subject providing the skin sample, preferably the method being for assessing a severity of the Genitourinary Syndrome of Menopause of the female subject, or more preferably the method comprising an in situ non-invasive method conducted on the female subject; and/or

the method is performed by a device according to Claim 9 or 10.