CLAIMS

What is claimed is:

1. A non-invasive imaging device, comprising:

an illumination source comprising an incident light source to direct light upon skin; and

a detector for detecting the degree of polarization of light reflected from the skin.

2. The device of claim 1, wherein the illumination source is positioned to direct light at a selected angle alpha.

3. The device of claim 2, wherein varying alpha varies the depth of the measurement of the layers in the skin.

4. The device of claim 3, wherein each depth has a specific angle which produces a full polarized reflection.

5. The device of claim 1, wherein the incident light source is an unpolarized light source.

6. The device of claim 1, wherein the incident light source is a polarized light source.

7. The device of claim 5, wherein the unpolarized light is at least one of white light, light of a single wavelength, and light of multiple single wavelengths.

8. The device of claim 1, further comprising a sensor for capturing an image of the reflected light.

9. The device of claim 1, further comprising an optical facility for detecting reflected light from the skin.

10. The device of claim 1, further comprising a communication facility for transmitting the detected information.

11. The device of claim 1, further comprising a storage facility for storing information collected by the device.

12. A method of determining a skin state, comprising:

illuminating skin with an incident light source;

detecting the degree of polarization of light reflected from the skin; and

determining a skin state based on an aspect of the polarization of the reflected light.

13. The method of claim 12, wherein the incident light is directed at a selected angle alpha.
14. The method of claim 13, wherein varying alpha varies the depth of the measurement of the layers in the skin.
15. The method of claim 14, wherein each depth has a specific angle which produces a full polarized reflection.
16. The method of claim 12, wherein the incident light is unpolarized light.
17. The method of claim 16, wherein the unpolarized light is at least one of white light, light of a single wavelength, and light of multiple single wavelengths.
18. The method of claim 12, wherein the incident light is polarized light.
19. The method of claim 12, wherein the aspect of the polarization is at least one of an orientation, an amplitude, a phase, an angle, a shape, a degree, and an amount.
20. The method of claim 12, wherein determining is done using an algorithm.
21. The method of claim 20 wherein the algorithm involves artificial neural networks.
22. The method of claim 20 , wherein the algorithm uses fuzzy logic.
23. The method of claim 20 wherein the algorithm involves fractal and multi-fractal analysis.
24. The method of claim 12, further comprising, filtering the reflected light to obtain polarized light of a wavelength defined by the filter output.
25. The method of claim 24, wherein algorithmic analysis is performed on the filtered image.
26. The method of claim 12, wherein determining involves creating an image of the difference between reflected diffusion light and reflected polarized light.
27. The method of claim 12, wherein determining involves comparing the aspect of the polarization of the reflected light to a calibration signal.
28. The method of claim 12, wherein determining further comprises considering at least one of user input and a visual analysis.
29. A non-invasive imaging device, comprising:

an illumination source comprising an incident light source to direct light upon an area of concern; and

a detector for detecting the degree of polarization of light reflected from the area of concern.

30. The device of claim 29, wherein the illumination source is positioned to direct light at a selected angle alpha.

31. The device of claim 29, wherein varying alpha varies the depth of the measurement of the layers of the area of concern.

32. The device of claim 31, wherein each depth has a specific angle which produces a full polarized reflection.

33. The device of claim 29, wherein the incident light source is an unpolarized light source.

34. The device of claim 33, wherein the unpolarized light is white light.

35. The device of claim 33, wherein the unpolarized light is of a single wavelength.

36. The device of claim 33, wherein the unpolarized light is of multiple wavelengths.

37. The device of claim 29, wherein the incident light source is polarized light.

38. The device of claim 29, further comprising a sensor for capturing an image of the reflected light.

39. The device of claim 29, further comprising an optical facility for detecting reflected light from the skin.

40. The device of claim 29, further comprising a communication facility for transmitting the detected information.

41. The device of claim 29, further comprising a storage facility for storing information collected by the device.

42. A method of determining a moisture level in the skin, comprising:

emitting incident light towards a skin structure;

detecting a degree of polarization and diffusion of the light reflected by the skin structure; and

determining a moisture level based on the amount of polarized and diffused reflected light.

43. The method of claim 42, further comprising, combining the assessment of moisture level with skin color measurements to determine luminosity.

44. The method of claim 42, wherein the incident light is unpolarized light.

45. The method of claim 44, wherein the unpolarized light is white light.

46. The method of claim 44, wherein the unpolarized light is of a single wavelength.

47. The method of claim 44, wherein the unpolarized light is of multiple wavelengths.

48. The method of claim 42 wherein determining involves use of an algorithm.

49. The method of claim 42, wherein determining a moisture level is based on the ratio of polarized and diffuse light.

50. A method of determining elasticity of the skin, comprising:

emitting incident light towards a skin structure;

detecting an aspect of polarization of the light reflected by the skin structure;

correlating the aspect of polarization with a concentration of elastin; and

determining an elasticity level based on the concentration of elastin.

51. The method of claim 50 wherein determining involves use of an algorithm.

52. The method of claim 50, wherein the incident light is unpolarized light.

53. The method of claim 52, wherein the unpolarized light is white light.

54. The method of claim 52, wherein the unpolarized light is of a single wavelength.

55. The method of claim 52, wherein the unpolarized light is of multiple wavelengths.

56. A method of determining firmness of the skin, comprising:

emitting incident light towards a skin structure;

detecting an aspect of polarization of the light reflected by the skin structure;

correlating the aspect of polarization with a concentration of at least one of an elastin, a collagen, and an activity of a sebaceous gland; and

determining firmness based on the concentration of at least one of elastin and collagen and sebaceous gland activity.

57. The method of claim 56, wherein the sebaceous gland activity is indicated by at least one of a number of glands, percent of glands open/closed, and level of clog/ fill.

58. The method of claim 56 wherein correlating involves use of an algorithm.

59. A method for obtaining dermal biophysical properties, comprising: performing a spectral analysis of image data acquired from the degree of polarization of reflections of incident light from skin structures, wherein the property is at least one of a structure, form, concentration, number, size, state, and stage of at least one of a:

melanocyte, melanin, hemoglobin, porphyrin, keratin, carotene, collagen, elastin, sebum, sebaceous gland activity, pore (sweat and sebaceous), moisture level, elasticity, luminosity, firmness, fine line, wrinkle count and stage, pore size, percent of open pores, skin elasticity, skin tension line, spot, skin color, psoriasis, allergies, red area, general skin disorder or infection, tumor, sunburn, rash, scratch, pimple, acne, insect bite, itch, bleeding, injury, inflammation, photodamage, pigmentation, tone, tattoo, percent burn/ burn classification, mole (naevi, nevus), aspect of a skin lesion (structure, color, dimensions/asymmetry), melanoma, dermally observed disorder, cutaneous lesion, cellulite, boil, blistering disease, congenital dermal syndrome, (sub)-cutaneous mycoses, melasma, vascular condition, rosacea, spider vein, texture, skin ulcer, wound healing, post-operative tracking, melanocytic lesion, non-melanocytic lesion, basal cell carcinoma, seborrhoic keratosis, sebum (oiliness), and nail- and/or hair-related concern.

60. A method for determining a skin state, comprising:

obtaining the answers to a series of subjective questions regarding the skin;

obtaining an objective skin analysis using a dermal imaging device; and

combining the subjective and objective results algorithmically to obtain a skin state.

61. A system for providing recommendations for skin care based on a skin state and a skin care goal, comprising:

obtaining a skin state of an individual;

categorizing the individual by skin state; and

recommending products and regimens that are effective for other individuals of the category in achieving the skin care goal.

62. The system of claim 61, wherein the system is operable over a network.

63. The system of claim 61, wherein the skin state is determined based on analysis of the degree of polarization of light reflected from the skin of the individual.

64. The system of claim 61, wherein the skin state is determined based on analysis of the difference between diffuse light reflected from the skin of the individual and polarized light reflected from the skin of the individual.

65. A method for tracking the effectiveness of a skin care product or regimen, comprising:

obtaining a baseline skin state assessment;

recommending a monitoring interval based on at least one of the skin care goal, product, and regimen;

obtaining a second skin state assessment;

comparing the second assessment to the baseline assessment to determine progress towards a skin care goal; and

optionally, optimizing the regimen or product in order to improve a skin state.

66. The method of claim 65, wherein the skin assessment is based on analysis of the degree of polarization of light reflected from the skin of the individual.

67. The method of claim 65, wherein the skin assessment is based on analysis of the difference between diffuse light reflected from the skin of the individual and polarized light reflected from the skin of the individual.

68. A personalized skin condition analysis system, comprising:

an imaging device, comprising:

an illumination source comprising an incident light source to direct light upon skin; and

a detector for detecting the degree of polarization of light reflected from the skin; and

a user interface for controlling the device.

69. The system of claim 68, wherein the device is adapted to interact with a physical interface to download image data to update a record of at least one of a

practitioner, a spa, a salon, cosmetic sales, a cosmetics manufacturer, a clinical trials database, and a third party database.

70. The system of claim 68, wherein the illumination source is positioned to direct light at a selected angle alpha.

71. The system of claim 70, wherein varying alpha varies the depth of the measurement of the layers in the skin.

72. The system of claim 71, wherein each depth has a specific angle which produces a full polarized reflection.

73. The system of claim 68, wherein the incident light source is an unpolarized light source.

74. The system of claim 73, wherein the unpolarized light is white light.

75. The system of claim 73, wherein the unpolarized light is of a single wavelength.

76. The system of claim 73, wherein the unpolarized light is of multiple wavelengths.

77. The system of claim 68, further comprising an optical facility for detecting reflected light from the skin.

78. The system of claim 68, further comprising a sensor for capturing an image of the reflected light.

79. The system of claim 68, further comprising a communication facility for transmitting the detected information.

80. The system of claim 68, further comprising a storage facility for storing information collected by the device.

81. A non-invasive imaging device, comprising:

an illumination source comprising an incident light source to direct light upon skin; and

a detector for detecting a characteristic of the light reflected from the skin.

82. The device of claim 81, wherein the illumination source is positioned to direct light at a selected angle alpha.

83. The device of claim 82, wherein varying alpha varies the depth of the measurement of the layers in the skin.

84. The device of claim 83, wherein each depth has a specific angle which produces a full polarized reflection.

85. The device of claim 81, wherein the incident light source is a polarized light source.

86. The device of claim 81, wherein the incident light source is an unpolarized light source.

87. The device of claim 85, wherein the unpolarized light is at least one of white light, light of a single wavelength, and light of multiple single wavelengths.

88. The device of claim 81, further comprising a sensor for capturing an image of the reflected light.

89. The device of claim 81, further comprising an optical facility for detecting reflected light from the skin.

90. The device of claim 81, further comprising a communication facility for transmitting the detected information.

91. The device of claim 81, further comprising a storage facility for storing information collected by the device.

92. The device of claim 81, wherein the reflected light is at least one of polarized light and unpolarized light.

93. A method of determining a skin state, comprising:

illuminating skin with an incident light source;

detecting a characteristic of the light reflected from the skin; and

determining a skin state based on at least one characteristic of the reflected light.

94. The method of claim 93, wherein the incident light is directed at a selected angle alpha.

95. The method of claim 94, wherein varying alpha varies the depth of the measurement of the layers in the skin.

96. The method of claim 95, wherein each depth has a specific angle which produces a full polarized reflection.

97. The method of claim 93, wherein the incident light is unpolarized light.

98. The method of claim 97, wherein the unpolarized light is at least one of white light, light of a single wavelength, and light of multiple single wavelengths.

99. The method of claim 93, wherein the incident light is polarized light.

100. The method of claim 93, wherein the reflected light is at least one of polarized light and unpolarized light.

101. The method of claim 93, wherein the characteristic is at least one of light source, light intensity, wavelength of light, angle of light, electrical and magnetic properties of the light, and polarization state of the light.

102. The method of claim 101, wherein an aspect of the polarization is at least one of an orientation, an amplitude, a phase, an angle, a shape, a degree, and an amount.

103. The method of claim 93, wherein determining is done using an algorithm.

104. The method of claim 103, wherein the algorithm involves artificial neural networks.

105. The method of claim 103, wherein the algorithm uses fuzzy logic.

106. The method of claim 103, wherein the algorithm involves fractal and multi-fractal analysis.

107. The method of claim 93, further comprising, filtering the reflected light to obtain light of a wavelength defined by the filter output.

108. The method of claim 107, wherein algorithmic analysis is performed on the filtered image.

109. The method of claim 93, wherein determining involves creating an image of the difference between reflected diffusion light and reflected polarized light.

110. The method of claim 93, wherein determining involves comparing the aspect of the polarization of the reflected light to a calibration signal.

111. The method of claim 93, wherein determining further comprises considering at least one of user input and a visual analysis.

112. A non-invasive imaging device, comprising:

an illumination source comprising an incident light source to direct light upon an area of concern; and

a detector for detecting a characteristic of the light reflected from the area of concern.

113. The device of claim 112, wherein the illumination source is positioned to direct light at a selected angle alpha.

114. The device of claim 112, wherein varying alpha varies the depth of the measurement of the layers of the area of concern.
115. The device of claim 114, wherein each depth has a specific angle which produces a full polarized reflection.
116. The device of claim 112, wherein the incident light source is an unpolarized light source.
117. The device of claim 116, wherein the unpolarized light is white light.
118. The device of claim 116, wherein the unpolarized light is of a single wavelength.
119. The device of claim 116, wherein the unpolarized light is of multiple wavelengths.
120. The device of claim 112, wherein the incident light source is polarized light.
121. The device of claim 112, wherein the reflected light is at least one of polarized light and unpolarized light.
122. The device of claim 112, wherein the characteristic is at least one of light source, light intensity, wavelength of light, angle of light, electrical and magnetic properties of the light, and polarization state of the light.
123. The device of claim 122, wherein an aspect of the polarization is at least one of an orientation, an amplitude, a phase, an angle, a shape, a degree, and an amount.
124. The device of claim 112, further comprising a sensor for capturing an image of the reflected light.
125. The device of claim 112, further comprising an optical facility for detecting reflected light from the skin.
126. The device of claim 112, further comprising a communication facility for transmitting the detected information.
127. The device of claim 112, further comprising a storage facility for storing information collected by the device.

CLAIMS

1. A non-invasive imaging device, comprising:

an illumination source comprising an incident light source to direct light upon skin; and

a detector for detecting the degree of polarization or a characteristic of light reflected from the skin,

wherein the illumination source is configured to (i) direct light upon the skin at a selected angle alpha, and (ii) vary alpha so as to vary the depth of the measurement of the layers in the skin.

2. The device of claim 1, wherein each depth has a specific angle which produces a full polarized reflection.

3. The device of claim 1 or claim 2, further comprising a sensor for capturing an image of the reflected light.

4. The device of any one of claims 1 to 3, further comprising an optical facility for detecting reflected light from the skin.

5. A method of determining a skin state, comprising:

illuminating skin with an incident light source at a selected angle alpha;

varying alpha so as to vary the depth of the measurement of the layers in the skin;

detecting the degree of polarization of light reflected from the skin; and

determining a skin state based on an aspect of the polarization or at least one characteristic of the reflected light.

6. The method of claim 5, wherein each depth has a specific angle which produces a full polarized reflection.

7. The method of claim 5 or claim 6 , wherein the aspect of the polarization is at least one of an orientation, an amplitude, a phase, an angle, a shape, a degree, and an amount.

8. The method of any one of claims 5 to 7, wherein determining is done using an algorithm.

9. The method of any one of claims 5 to 8, further comprising, filtering the reflected light to obtain polarized light of a wavelength defined by the filter output.

10. A method of determining a moisture level in the skin, comprising:

illuminating skin with an incident light source at a selected angle alpha;

varying alpha so as to vary the depth of the measurement of the layers in the skin;

detecting a degree of polarization and diffusion of the light reflected by the skin structure; and

determining a moisture level based on the amount of polarized and diffused reflected light.

11. The method of claim 10, further comprising, combining the assessment of moisture level with skin color measurements to determine luminosity.

12. The method of claim 11, wherein determining a moisture level is based on the ratio of polarized and diffuse light.

13. A method of determining elasticity of the skin, comprising:

illuminating skin with an incident light source at a selected angle alpha;

varying alpha so as to vary the depth of the measurement of the layers in the skin;

detecting an aspect of polarization of the light reflected by the skin structure;

correlating the aspect of polarization with a concentration of elastin; and

determining an elasticity level based on the concentration of elastin.

14. A method of determining firmness of the skin, comprising:

illuminating skin with an incident light source at a selected angle alpha;

varying alpha so as to vary the depth of the measurement of the layers in the skin;

detecting an aspect of polarization of the light reflected by the skin structure;

correlating the aspect of polarization with a concentration of at least one of an elastin, a collagen, and an activity of a sebaceous gland; and

determining firmness based on the concentration of at least one of elastin and collagen and sebaceous gland activity.

15. A method for determining a skin state, comprising:

obtaining the answers to a series of subjective questions regarding the skin;

obtaining an objective skin analysis using the non-invasive imaging device of any one of claims 1 to 4; and

combining the subjective and objective results algorithmically to obtain a skin state.

16. A system for providing recommendations for skin care based on a skin state and a skin care goal, comprising:

obtaining a skin state of an individual by the method of any one of claims 5 to 15;

categorizing the individual by skin state; and

recommending products and regimens that are effective for other individuals of the category in achieving the skin care goal.

17. The system of claim 16, wherein the skin state is determined based on analysis of the degree of polarization of light reflected from the skin of the individual.

18. The system of claim 16 or claim 17, wherein the skin state is determined based on analysis of the difference between diffuse light reflected from the skin of the individual and polarized light reflected from the skin of the individual.

19. A method for tracking the effectiveness of a skin care product or regimen, comprising:

obtaining a baseline skin state by the method of any one of claims 5 to 15;

recommending a monitoring interval based on at least one of the skin care goal, product, and regimen;

obtaining a second skin state by the method of any one of claims 5 to 15;

comparing the second skin state to the baseline skin state to determine progress towards a skin care goal; and

optionally, optimizing the regimen or product in order to improve a skin state.