CLAIMS

1. A microneedle array for use in sensing an analyte, comprising:

a plurality of solid microneedles, wherein at least one microneedle comprises:

a tapered distal portion having an insulated distal apex; and

an electrode on a surface of the tapered distal portion, wherein the electrode is located proximal to the insulated distal apex.

2. The microneedle array of claim 1, wherein the electrode is a working electrode configured to sense at least one analyte and the at least one microneedle comprises a biorecognition layer arranged over the working electrode, wherein the biorecognition layer comprises a biorecognition element.

3. The microneedle array of claim 2, wherein the biorecognition element comprises an enzyme.

4. The microneedle array of claim 3, wherein the enzyme is ~~an oxidoreductase~~glucose oxidase.

~~5. The microneedle array of claim 4, wherein the oxidoreductase is at least one of lactate oxidase, alcohol oxidase, beta-hydroxybutyrate dehydrogenase, tyrosinase, catalase, ascorbate oxidase, cholesterol oxidase, choline oxidase, pyruvate oxidase, urate oxidase, urease, and xanthine oxidase.~~

~~6. The microneedle array of claim 4, wherein the oxidoreductase is glucose oxidase.~~

~~7. The microneedle array of claim 2, wherein the biorecognition element is cross-linked with an amine-condensing carbonyl chemical species.~~

~~8. The microneedle array of claim 7, wherein the amine-condensing carbonyl chemical species is at least one of formaldehyde, glyoxal, malonaldehyde, and succinaldehyde.~~

~~9. The microneedle array of claim 7, wherein the amine-condensing carbonyl chemical species is glutaraldehyde.~~

~~10~~5. The microneedle array of claim 2, wherein the at least one microneedle comprises at least one of a diffusion-limiting layer and a hydrophilic layer arranged over the biorecognition layer.

~~11~~6. The microneedle array of claim 2, wherein the microneedle array comprises at least one microneedle comprising a counter electrode configured to source or sink current to sustain an electrochemical reaction on the working electrode.

~~12~~7. The microneedle array of claim 2, wherein the microneedle array comprises at least one microneedle comprising a reference electrode configured to provide a reference potential for the working electrode.

~~13. The microneedle array of claim 12, further comprising a conducting polymer arranged over the reference electrode.~~

~~14. The microneedle array of claim 13, wherein the conducting polymer comprises a dopant.~~

~~15. The microneedle array of claim 13, wherein the reference electrode comprises a metal oxide with a stable electrode potential.~~

~~16. The microneedle array of claim 15, wherein the metal oxide comprises iridium oxide.~~

~~17. The microneedle array of claim 13, wherein the reference electrode comprises a metal salt with a stable electrode potential.~~

~~18. The microneedle array of claim 17, wherein the metal salt comprises silver chloride.~~

~~19~~8. The microneedle array of claim 1, wherein the entirety of the electrode is on the tapered distal portion of the at least one microneedle.

~~20. The microneedle array of claim 1, wherein the electrode comprises a catalytic surface.~~

~~21. The microneedle array of claim 20, wherein the catalytic surface comprises at least one of platinum, palladium, iridium, rhodium, gold, ruthenium, titanium, nickel, carbon, and doped diamond.~~

~~22. The microneedle array of claim 20, wherein the at least one microneedle comprises platinum black arranged over the electrode.~~

~~23~~9. The microneedle array of claim 1, wherein a distal end of the electrode is offset from the distal apex by an offset distance of at least about 10 μm, wherein the offset distance is measured along a longitudinal axis of the at least one microneedle.

~~24~~10. The microneedle array of claim 1, wherein the electrode is annular.

~~25~~11. The microneedle array of claim 1, wherein a portion of the working electrode is recessed into the tapered distal portion.

~~26~~12. The microneedle array of claim 1, wherein the electrode is on only a segment of the tapered distal portion.

~~27~~13. The microneedle array of claim 1, further comprising an electrical contact, wherein the at least one microneedle comprises a body portion providing a conductive pathway between the electrical contact and the electrode.

~~28~~14. The microneedle array of claim ~~27~~13, wherein the body portion is formed from a conductive material.

~~29. The microneedle array of claim 27, wherein the body portion comprises an embedded pathway.~~

~~30~~15. The microneedle array of claim ~~27~~13, wherein the body portion is insulated.

~~31. The microneedle array of claim 27, wherein the body portion has a circular, square, or an octagonal base.~~

~~32. The microneedle array of claim 27, wherein at least a segment of the body portion is columnar.~~

~~33. The microneedle array of claim 27, wherein at least a segment of the body portion is pyramidal.~~

~~34. The microneedle array of claim 33, wherein at least a portion of the body portion has a first taper angle measured relative to a base of the body portion and the distal apex has a second taper angle measured relative to the base, wherein the second taper angle is greater than the first taper angle.~~

~~35. The microneedle array of claim 34, wherein at least one of the body portion and the distal portion of the microneedle is radially asymmetric.~~

~~36. The microneedle array of claim 35, wherein the tapered distal portion comprises a planar surface that is offset from the distal apex of the at least one microneedle.~~

~~37~~16. The microneedle array of claim 1, wherein each of the microneedles in the plurality of microneedles comprises a

a tapered distal portion having an insulated distal apex; and

an electrode on a surface of the tapered distal portion, wherein the electrode is located proximal to the insulated distal apex.

~~38~~17. The microneedle array of claim 1, wherein the microneedles of the plurality of microneedles are electrically insulated from one another.

~~39~~18. The microneedle array of claim ~~38~~17, wherein the microneedle array is configured to detect multiple analytes.

~~40~~19. The microneedle array of claim 1, wherein the microneedles of the plurality of microneedles are arranged in a periodic grid.

~~41. The microneedle array of claim 40, wherein the periodic grid comprises a rectangular array.~~

~~42. The microneedle array of claim 40, wherein the periodic grid comprises a hexagonal array.~~

~~43. The microneedle array of claim 40, wherein the microneedles in the periodic grid are spaced apart by a distance between about 200 μm and about 800 μm.~~

~~44. The microneedle array of claim 40, wherein the microneedles in the periodic grid are uniformly spaced apart.~~

~~45. The microneedle array of claim 1, wherein the plurality of microneedles comprises at least one delivery microneedle with a lumen.~~

~~46~~20. The microneedle array of claim 1, wherein the at least one microneedle is configured to puncture skin of a user and sense an analyte in interstitial fluid in a dermal layer of the user.

~~47~~21. An analyte monitoring system comprising the microneedle array of claim 1 and a wearable housing, wherein the microneedle array extends outwardly from the housing.

~~48~~22. The system of claim ~~47~~21, wherein the at least one microneedle extends from the housing such that a distal end of the electrode is located less than about 5 mm from the housing.

~~49. The system of claim 48, wherein the at least one microneedle extends from the housing such that the distal end of the electrode is located less than about 1 mm from the housing.~~

~~50~~23. The system of claim ~~47~~21, wherein the housing encloses an electronics system comprising at least one of a processor and a wireless communication module.

~~51~~24. The system of claim ~~50~~23, wherein the electronics system comprises a wireless communication module and the system further comprises a software application executable on a mobile computing device to be paired with the wireless communication module.

~~52~~25. The system of claim ~~47~~21, wherein the housing comprises one or more indicator lights configured to communicate status information.

~~53~~26. The system of claim ~~52~~25, wherein at least one of the indicator lights is configured to be selectively illuminated in accordance with an illumination mode corresponding to an analyte measurement status.

~~54~~27. The system of claim ~~53~~26, wherein at least one of the indicator lights is configured to be selectively illuminated to communicate a current analyte measurement level.

~~55. The system of claim 53, wherein the user interface comprises a plurality of indicator lights configured to be selectively illuminated in a progressive sequence to communicate an analyte measurement trend.~~

~~56. The system of claim 55, wherein the plurality of indicator lights is configured to be selectively illuminated in a first progressive sequence in a first direction to communicate a rising analyte measurement trend, and is further configured to be selectively illuminated in a second progressive sequence in a second direction to communicate a falling analyte measurement trend.~~

~~57~~28. The system of claim ~~52~~25, wherein the user interface is further configured to communicate information indicative of a status of the analyte monitoring device.

~~58~~29. The system of claim ~~47~~21, further comprising an adhesive configured to couple the housing to the skin of a user.

~~59~~30. The system of claim ~~47~~21, further comprising an applicator configured to apply the at least a portion of the analyte monitoring system to the skin of a user.

~~60. The system of claim 47, wherein the analyte monitoring system is a skin-adhered patch.~~

~~61. The system of claim 47, wherein the plurality of microneedles comprises at least one delivery microneedle with a lumen.~~

~~62. The system of claim 47, wherein the plurality of microneedles comprises at least one solid microneedle comprising a coating comprising a therapeutic substance.~~

~~63. The system of claim 62, wherein the therapeutic substance comprises at least one of insulin, glucagon, metformin, acetaminophen, acetylsalicylic acid, isobutylphenylpropionic acid, levodopa, a statin, a hydrocodone, an opioid, a non-steroidal anti-inflammatory, an anesthetic, an analgesic, an anticonvulsant, an antidepressant, an antipsychotic, a sedative, a relaxant, a hormonal agent, an antibacterial agent, and an antiviral agent.~~

~~64~~31. A method for monitoring a user, comprising:

accessing a body fluid of the user with an analyte monitoring device; and

quantifying one or more analytes in the body fluid using the analyte monitoring device,

wherein the analyte monitoring device comprises a plurality of solid microneedles, wherein at least one microneedle comprises:

a tapered distal portion having an insulated distal apex; and

an electrode on a surface of the tapered distal portion, wherein the electrode is located proximal to the insulated distal apex.

~~65. The method of claim 64, wherein the body fluid comprises a dermal interstitial fluid of the user.~~

~~66. The method of claim 64, wherein the one or more analytes comprises glucose.~~

~~67~~32. A microneedle array for use in sensing an analyte, comprising:

a plurality of solid microneedles, wherein at least one microneedle comprises:

a tapered distal portion having an insulated distal apex; and

an electrode on a surface of the tapered distal portion, wherein a distal end of the electrode is offset from the distal apex.

~~68. The microneedle array of claim 67, wherein the electrode is a working electrode configured to sense at least one analyte and the at least one microneedle comprises a biorecognition layer arranged over the working electrode, wherein the biorecognition layer comprises a biorecognition element.~~

~~69. The microneedle array of claim 68, wherein the biorecognition element comprises glucose oxidase.~~

~~70. The microneedle array of claim 67, wherein the distal end of the electrode is offset from the distal apex by an offset distance of at least about 10 μm, wherein the offset distance is measured along a longitudinal axis of the at least one microneedle.~~

~~71. The microneedle array of claim 67, wherein the electrode is annular.~~

~~72. The microneedle array of claim 67, wherein in at least one microneedle, a portion of the working electrode is recessed into the tapered distal portion.~~

~~73. The microneedle array of claim 67, wherein the electrode is on only a segment of the tapered distal portion.~~

~~74. The microneedle array of claim 67, further comprising an electrical contact, wherein the at least one microneedle comprises a body portion providing a conductive pathway between the electrical contact and the electrode.~~

~~75. The microneedle array of claim 67, wherein each of the microneedles in the plurality of microneedles comprises a~~

~~a tapered distal portion having an insulated distal apex; and~~

~~an electrode on a surface of the tapered distal portion, wherein the electrode is located proximal to the insulated distal apex.~~

~~76. The microneedle array of claim 67, wherein the microneedle array comprises a plurality of working electrodes, wherein each working electrode is individually addressable and electrically isolated from every other working electrode in the analyte monitoring device.~~

~~77. The microneedle array of claim 76, wherein the microneedle array is configured to detect multiple analytes.~~

~~78. The microneedle array of claim 67, wherein the microneedles of the plurality of microneedles are arranged in a hexagonal array.~~

~~79. The microneedle array of claim 67, wherein the at least one microneedle is configured to puncture skin of a user and sense an analyte in interstitial fluid in a dermal layer of the user.~~

~~80. An analyte monitoring system comprising the microneedle array of claim 67 and a wearable housing, wherein the microneedle array extends outwardly from the housing.~~

~~81. The system of claim 80, wherein the at least one microneedle extends from the housing such that the distal end of the electrode is located less than about 5 mm from the housing.~~

~~82. The system of claim 80, wherein the housing encloses an electronics system comprising a wireless communication module and the system further comprises a software application executable on a mobile computing device to be paired with the wireless communication module.~~

~~83. The system of claim 80, wherein the housing comprises a user interface comprising one or more indicator lights configured to communicate status information.~~

~~84. The system of claim 83, wherein at least one of the indicator lights is configured to be selectively illuminated in accordance with an illumination mode corresponding to an analyte measurement status.~~

~~85. The system of claim 83, wherein the analyte monitoring system comprises a skin-adhered patch.~~

~~86. A method of sterilizing an analyte monitoring device, the method comprising:~~

~~exposing the analyte monitoring device to a sterilant gas, wherein the analyte monitoring device comprises a wearable housing, a microneedle array extending from the housing and comprising an analyte sensor, and an electronics system arranged in the housing and electrically coupled to the microneedle array,~~

~~wherein the analyte monitoring device is exposed to the sterilant gas for a dwell time sufficient to sterilize the analyte monitoring device.~~

~~87. The method of claim 86, wherein the sterilant gas is suitable for oxidative sterilization.~~

~~88. The method of claim 87, wherein the sterilant gas comprises ethylene oxide.~~

~~89. The method of claim 86, wherein the analyte sensor comprises an electrode.~~

~~90. The method of claim 89, wherein the analyte sensor comprises a biorecognition layer arranged over the electrode, wherein the biorecognition layer comprises a biorecognition element.~~

~~91. The method of claim 90, wherein the biorecognition element comprises an enzyme.~~

~~92. The method of claim 91, wherein the enzyme is an oxidoreductase.~~

~~93. The method of claim 92, wherein the oxidoreductase is at least one of lactate oxidase, alcohol oxidase, beta-hydroxybutyrate dehydrogenase, tyrosinase, catalase, ascorbate oxidase, cholesterol oxidase, choline oxidase, pyruvate oxidase, urate oxidase, urease, and xanthine oxidase.~~

~~94. The method of claim 92, wherein the oxidoreductase is glucose oxidase.~~

~~95. The method of claim 90, wherein the biorecognition element is cross-linked with an amine-condensing carbonyl chemical species.~~

~~96. The method of claim 95, wherein the amine-condensing carbonyl chemical species is at least one of formaldehyde, glyoxal, malonaldehyde, and succinaldehyde.~~

~~97. The method of claim 95, wherein the amine-condensing carbonyl chemical species is glutaraldehyde.~~

~~98. The method of claim 90, wherein the biorecognition layer is formed at least in part by cross-linking the biorecognition element to form cross-linked biorecognition element aggregates, and embedding the cross-linked biorecognition element aggregates in a conducting polymer.~~

~~99. The method of claim 98, wherein embedding the cross-linked biorecognition element aggregates comprises embedding only cross-linked biorecognition element aggregates having at least a threshold molecular weight.~~

~~100. The method of claim 86, wherein exposing the analyte monitoring device to the sterilant gas comprises injecting the sterilant gas into a compartment containing the analyte monitoring device, and heating the compartment to a sterilization temperature.~~

~~101. The method of claim 100, wherein the sterilization temperature is below about 45 degrees Celsius and the dwell time is at least about 2 hours.~~

~~102. The method of claim 86, further comprising preconditioning the analyte monitoring device prior to exposing the analyte monitoring device to the sterilant gas, wherein preconditioning the analyte comprises exposing the analyte monitoring device to steam.~~

~~103~~33. A microneedle array for an analyte monitoring device, the microneedle array comprising:

a plurality of solid sensing microneedles, wherein each sensing microneedle comprises:

a tapered distal portion comprising a working electrode configured to sense an analyte; and

a body portion providing a conductive connection to the working electrode,

wherein the body portion of each sensing microneedle is insulated such that each working electrode is individually addressable and electrically isolated from every other working electrode in the microneedle array.

~~104. The microneedle array of claim 103, wherein at least one sensing microneedle comprises a biorecognition layer arranged over the working electrode, wherein the biorecognition layer comprises a biorecognition element.~~

~~105. The microneedle array of claim 104, wherein the biorecognition element comprises an enzyme.~~

~~106. The microneedle array of claim 105, wherein the enzyme is an oxidoreductase.~~

~~107. The microneedle array of claim 106, wherein the oxidoreductase is at least one of lactate oxidase, alcohol oxidase, beta-hydroxybutyrate dehydrogenase, tyrosinase, catalase, ascorbate~~

~~oxidase, cholesterol oxidase, choline oxidase, pyruvate oxidase, urate oxidase, urease, and xanthine oxidase.~~

~~108. The microneedle array of claim 106, wherein the oxidoreductase is glucose oxidase.~~

~~109. The microneedle array of claim 104, wherein the biorecognition element is cross-linked with an amine-condensing carbonyl chemical species.~~

~~110. The microneedle array of claim 109, wherein the amine-condensing carbonyl chemical species is at least one of formaldehyde, glyoxal, malonaldehyde, and succinaldehyde.~~

~~111. The microneedle array of claim 109, wherein the amine-condensing carbonyl chemical species is glutaraldehyde.~~

~~112. The microneedle array of claim 104, wherein the at least one sensing microneedle comprises at least one of a diffusion-limiting layer and a hydrophilic layer arranged over the biorecognition layer.~~

~~113. The microneedle array of claim 103, wherein the microneedle array further comprises at least one microneedle comprising a counter electrode configured to source or sink current to sustain an electrochemical reaction on the working electrode of at least one sensing microneedle.~~

~~114. The microneedle array of claim 103, wherein the plurality of microneedles comprises at least one microneedle comprising a reference electrode configured to provide a reference potential for the working electrode.~~

~~115. The microneedle array of claim 114, further comprising a conducting polymer arranged over the reference electrode.~~

~~116. The microneedle array of claim 115, wherein the conducting polymer comprises a dopant.~~

~~117. The microneedle array of claim 114, wherein the reference electrode comprises a metal oxide with a stable electrode potential.~~

~~118. The microneedle array of claim 117, wherein the metal oxide comprises iridium oxide.~~

~~119. The microneedle array of claim 114, wherein the reference electrode comprises a metal salt with a stable electrode potential.~~

~~120. The microneedle array of claim 119, wherein the metal salt comprises silver chloride.~~

~~121. The microneedle array of claim 103, wherein in at least one sensing microneedle, the tapered distal portion comprises an insulated distal apex and the working electrode is proximal to the insulated distal apex.~~

~~122. The microneedle array of claim 121, wherein a distal end of the working electrode is offset from the distal apex by an offset distance of at least about 10 μm, wherein the offset distance is measured along a longitudinal axis of the at least one sensing microneedle.~~

~~123. The microneedle array of claim 103, wherein in at least one sensing microneedle, a portion of the working electrode is recessed into the tapered distal portion.~~

~~124. An analyte monitoring device comprising the microneedle array of claim 103 and a wearable housing, wherein the microneedle array extends outwardly from the housing.~~

~~125. The analyte monitoring device of claim 124, wherein the housing comprises one or more indicator lights configured to communicate status information.~~

~~126. The analyte monitoring device of claim 124, wherein the housing encloses an electronics system comprising at least one of a processor and a wireless communication module.~~

~~127. The analyte monitoring device of claim 126, wherein the analyte monitoring device is a skin-adhered patch.~~

~~128. A microneedle array for a body-worn analyte monitoring device, wherein the microneedle array comprises:~~

~~at least one microneedle comprising:~~

~~a pyramidal body portion having a non-circular base; and~~

~~a tapered distal portion extending from the body portion and comprising an electrode,~~

~~wherein the distal portion comprises a planar surface that is offset from a distal apex of the at least one microneedle.~~

~~129. The microneedle array of claim 128, wherein at least a portion of the body portion has a first taper angle measured relative to the base and the distal apex has a second taper angle measured relative to the base, wherein the second taper angle is greater than the first taper angle.~~

~~130. The microneedle array of claim 128, wherein the second taper is between about 65 degrees and about 75 degrees.~~

~~131. The microneedle array of claim 130, wherein the first taper is between about 15 degrees and about 25 degrees.~~

~~132. The microneedle array of claim 128, wherein the planar surface is angled between about 75 degrees and 85 degrees measured relative to the base.~~

~~133. The microneedle array of claim 128, wherein the tapered distal portion comprises an insulated distal apex.~~

~~134. An analyte monitoring device comprising the microneedle array of claim 128 and a wearable housing, wherein the microneedle array is configurable to extend outwardly from the housing.~~

~~135. The analyte monitoring device of claim 134, wherein the analyte monitoring device is a patch.~~

~~136~~34. A method for monitoring a user, comprising:

accessing a dermal interstitial fluid of the user at a plurality of sensor locations with an integrated analyte monitoring device comprising a single microneedle array;

quantifying one or more analytes in the dermal interstitial fluid using a plurality of working electrodes in the microneedle array, wherein each working electrode is individually addressable and electrically isolated from every other working electrode in the analyte monitoring device.

~~137. The method of claim 136, wherein quantifying one or more analytes comprises quantifying a plurality of analytes in the dermal interstitial fluid using the plurality of working electrodes.~~

~~138. The method of claim 136, wherein the microneedle array comprises a plurality of sensing microneedles, each sensing microneedle comprising a respective working electrode.~~

~~139. The method of claim 138, wherein at least one sensing microneedle comprises a biorecognition layer arranged over the working electrode, wherein the biorecognition layer comprises an enzyme.~~

~~140. The method of claim 139, wherein the at least one microneedle comprises at least one of a diffusion-limiting layer and a hydrophilic layer arranged over the biorecognition layer.~~

~~141. The method of claim 136, wherein the microneedle array comprises at least one microneedle comprising a counter electrode configured to source or sink current to sustain an electrochemical reaction on at least one working electrode.~~

~~142. The method of claim 136, wherein the plurality of microneedles comprises at least one microneedle comprising a reference electrode configured to provide a reference potential for at least one working electrode.~~

~~143. The method of claim 142, further comprising a conducting polymer arranged over the reference electrode.~~

~~144. The method of claim 143, wherein the conducting polymer comprises a dopant.~~

~~145. The method of claim 142, wherein the reference electrode comprises a metal oxide with a stable electrode potential.~~

~~146. The method of claim 145, wherein the metal oxide comprises iridium oxide.~~

~~147. The method of claim 142, wherein the reference electrode comprises a metal salt with a stable electrode potential.~~

~~148. The method of claim 147, wherein the metal salt comprises silver chloride.~~

~~149. The method of claim 136, further comprising communicating status information indicative of the quantification of the one or more analytes.~~

~~150. The method of claim 149, wherein the microneedle array extends outwardly from a wearable housing and communicating status information comprises communicating status information via a user interface on the housing.~~

~~151. The method of claim 150, wherein communicating status information comprises selectively illuminating one or more indicator lights on the housing in accordance with an illumination mode corresponding to an analyte measurement status or a status of the integrated analyte monitoring device.~~

~~152. The method of claim 150, wherein communicating status information comprises activating a display corresponding to an analyte measurement status or a status of the integrated analyte monitoring device.~~

~~153~~35. A body-worn analyte monitoring device, comprising:

a wearable housing; and

a microneedle array extending outwardly from the housing and comprising at least one microneedle configured to measure one or more analytes in a user wearing the housing,

wherein the housing comprises a user interface configured to communicate information indicative of the measurement of the one or more analytes.

~~154. The device of claim 153, wherein the user interface comprises one or more indicator lights configured to be selectively illuminated in accordance with an illumination mode corresponding to an analyte measurement status or a status of an integrated analyte monitoring device.~~

~~155. The device of claim 154, wherein at least one of the indicator lights is configured to be selectively illuminated to communicate a current analyte measurement level.~~

~~156. The device of claim 154, wherein the user interface comprises a plurality of indicator lights configured to be selectively illuminated in a progressive sequence to communicate an analyte measurement trend.~~

~~157. The device of claim 156, wherein the plurality of indicator lights is configured to be selectively illuminated in a first progressive sequence in a first direction to communicate a rising analyte measurement trend.~~

~~158. The device of claim 156, wherein the plurality of indicator lights is configured to be selectively illuminated in a second progressive sequence in a second direction to communicate a falling analyte measurement trend.~~

~~159. The device of claim 153, wherein the user interface is further configured to communicate information indicative of a status of the analyte monitoring device.~~

~~160. The device of claim 153, wherein the user interface comprises a display screen.~~

~~161. The device of claim 153, wherein the analyte monitoring device is a skin-adhered patch.~~

~~162. The device of claim 153, wherein the at least one microneedle comprises a tapered distal portion with an insulated distal apex, and an electrode on a surface of the tapered distal portion, wherein the electrode is located proximal to the insulated distal apex.~~

~~163. The device of claim 153, wherein the microneedle array comprises a plurality of working electrodes, wherein each working electrode is individually addressable and electrically isolated from every other working electrode in the analyte monitoring device.~~

~~164~~36. A method for monitoring a user, comprising:

measuring one or more analytes in the user using a body-worn analyte monitoring device comprising a wearable housing and one or more analyte sensors;

communicating information indicative of the measurement of the one or more analytes through a user interface on the housing.

~~165. The method of claim 164, wherein communicating information comprises illuminating one or more indicator lights on the housing in accordance with an illumination mode corresponding to an analyte measurement status.~~

~~166. The method of claim 165, wherein communicating information comprises selectively illuminating at least one of the indicator lights to communicate a current analyte measurement level.~~

~~167. The method of claim 166, wherein communicating information comprises communicating the current analyte measurement level based on color of the illuminated indicator light, location of the illuminated indicator light, or both.~~

~~168. The method of claim 165, wherein communicating information comprises selectively illuminating a plurality of indicator lights on the housing in a progressive sequence to communicate an analyte measurement trend.~~

~~169. The method of claim 168, wherein communicating information comprises selectively illuminating the plurality of indicator lights in a first progressive sequence in a first direction to communicate a rising analyte measurement trend.~~

~~170. The method of claim 168, wherein communicating information comprises selectively illuminating the plurality of indicator lights in a second progressive sequence in a second direction to communicate a falling analyte measurement trend.~~

~~171. The method of claim 164, further comprising communicating information indicative of a status of the analyte monitoring device through the user interface.~~

~~172. The method of claim 164, further comprising accessing a dermal interstitial fluid of the user at a plurality of sensor locations with the analyte monitoring device, wherein quantifying one of more analytes comprises quantifying one or more analytes in the dermal interstitial fluid.~~

~~173. The method of claim 164, wherein the analyte monitoring device comprises a microneedle array comprising a plurality of working electrodes, wherein each working electrode is individually addressable and electrically isolated from every other working electrode in the analyte monitoring device.~~

37. A microneedle array for use in sensing an analyte, comprising:

a semiconductor substrate;

a plurality of solid microneedles extending from the substrate, wherein at least one microneedle of the plurality of microneedles is configured to sense an analyte in dermal interstitial fluid of a user and comprises:

a columnar body portion;

a tapered distal portion having an insulated distal apex; and

an annular working electrode coupled to a surface of the tapered distal portion, wherein a portion of the working electrode overlies and extends beyond an annular recess formed in the surface of the tapered distal portion, wherein the working electrode extends onto the surface of the tapered distal portion on each side of the annular recess.

38. A microneedle array for use in sensing an analyte, comprising:

a first microneedle comprising a working electrode, wherein the working electrode comprises a first electrode material and a biorecognition layer on the first electrode material, wherein the biorecognition layer comprises a biorecognition element configured to react with the analyte;

a second microneedle comprising a counter electrode, wherein the counter electrode comprises a second electrode material; and

a third microneedle comprising a reference electrode, wherein the reference electrode comprises a third electrode material and a redox-couple layer on the third electrode material, and

wherein a redox reaction occurs between the working electrode on the first microneedle and the counter electrode on the second microneedle.

39. A microneedle array for use in sensing glucose, comprising:

a first microneedle comprising a working electrode, wherein the working electrode comprises a platinum layer and a biorecognition layer on the platinum layer, wherein the biorecognition layer comprises a conducting polymer-entrapped glucose oxidase configured to react with the glucose;

a second microneedle comprising a counter electrode, wherein the counter electrode comprises a platinum layer; and

a third microneedle comprising a reference electrode, wherein the reference electrode comprises silver/silver chloride, and

wherein a redox reaction occurs between the working electrode on the first microneedle and the counter electrode on the second microneedle.

40. A method for sensing an analyte via a microneedle array, comprising:

providing a first microneedle comprising a working electrode, wherein the working electrode comprises a first electrode material and a biorecognition layer on the first electrode material, wherein the biorecognition layer comprises a biorecognition element configured to react with the analyte;

providing a second microneedle comprising a counter electrode, wherein the counter electrode comprises a second electrode material;

providing a third microneedle comprising a reference electrode, wherein the reference electrode comprises a third electrode material and a redox-couple layer on the third electrode material;

applying a bias potential between the working electrode and the reference electrode; and

measuring a current value between the working electrode and the counter electrode, the current value being proportional to a concentration of the analyte,

wherein a redox reaction occurs between the working electrode and the counter electrode.

41. A microneedle array for use in sensing an analyte, comprising:

a semiconductor substrate;

a plurality of solid microneedles extending from the substrate, wherein at least one microneedle of the plurality of microneedles is configured to sense an analyte in dermal interstitial fluid of a user and comprises:

a columnar body portion;

a tapered distal portion having an insulated distal apex; and

an annular working electrode on a surface of the tapered distal portion, wherein the working electrode comprises a proximal edge and a distal edge and is on only a segment of the surface of the tapered distal portion of the microneedle, and wherein the distal edge of the working electrode is proximate a proximal edge of the insulated distal apex.

42. A method for monitoring a user, comprising:

accessing a dermal interstitial fluid of the user with an analyte monitoring device; and

quantifying one or more analytes in the body fluid using the analyte monitoring device,

wherein the analyte monitoring device comprises a microneedle array comprising a semiconductor substrate and a plurality of solid microneedles extending from the substrate, wherein at least one microneedle of the plurality of microneedles comprises:

a columnar body portion;

a tapered distal portion having an insulated distal apex; and

an annular working electrode on a surface of the tapered distal portion, wherein the working electrode comprises a proximal edge and a distal edge and is on only a segment of the surface of the tapered distal portion of the microneedle, and wherein the distal edge of the working electrode is proximate a proximal edge of the insulated distal apex.