CLAIMS

What is claimed is:

1. An applicator for selectively affecting a subject's subcutaneous tissue, comprising:

a housing;

a treatment cup mounted in the housing, wherein the treatment cup defines a tissue-receiving cavity and includes a temperature-controlled surface;

at least one thermal device coupled to the treatment cup and configured to receive energy via a flexible connector coupled to the applicator and to cool the temperature-controlled surface; and

at least one vacuum port coupled to the treatment cup and configured to provide a vacuum to draw the subject's tissue into the tissue-receiving cavity and against at least a portion of a treatment area of the temperature-controlled surface to selectively damage and/or reduce the subject’s subcutaneous tissue,

wherein the applicator has one or more of the following:

(a) a ratio of the treatment area to weight greater than or equal to 5 square inches per lb, or

(b) a ratio of the treatment area to tissue-draw depth greater than or equal to 8 inches.

2. The applicator of claim 1, wherein the treatment area to weight ratio is greater than or equal to 7 square inches per lb.

3. The applicator of claim 2, wherein the treatment area to weight ratio is greater than or equal to 10 square inches per lb.

4. The applicator as in any one of claims 1-3, wherein the treatment area to depth ratio is greater than or equal to 10 inches.

5. The applicator as in any one of claims 1-4, wherein the treatment area to depth ratio is greater than or equal to 12 inches.

6. The applicator as in any one of claims 1-5, wherein the treatment cup has a cross-sectional surface profile having a curvature which approximates a parabolic polynomial of fourth order or higher.

7. The applicator as in any one of claims 1-6, wherein the temperature-controlled surface has an Ra less than or equal to 35.

8. The applicator as in any one of claims 1-7, further comprising a first anti-condensation housing and a second anti-condensation housing, wherein the at least one thermal device comprises a first thermal device and a second thermal device, the first and second thermal devices being located at opposite sides of the treatment cup and within the respective first and second anti-condensation housings.

9. The applicator of claim 8, wherein the first and second thermal devices each include:

one or more thermoelectric elements; and

a fluid-cooled element thermally coupled to the one or more thermoelectric elements, wherein the weight of the applicator increases less than 5% when the fluid-cooled element is filled with water.

10. The applicator as in any one of claims 8-9, wherein the first and second thermal devices each include a plurality of addressable thermoelectric elements.

11. The applicator as in any one of claims 9 and 10, wherein each thermoelectric element is independently controllable.

12. The applicator as in any one of claims 9-11, wherein each thermoelectric element includes: (a) a first surface coupled to a bottom surface of the treatment cup and (b) a second surface coupled to the fluid-cooled element, the second surface being opposite the first surface.

13. The applicator as in any one of claims 1-12, further comprising an interconnect assembly connected to the housing and configured to be detachably coupled to a flexible connector via a bayonet connection.

14. The applicator of claim 13, further comprising one or more vacuum lines through which air flows to draw tissue into the treatment cup when the flexible connector provides a vacuum.

15. The applicator as in any one of claims 1-14, wherein the housing is waterproof according to at least one of IPX1, IPX3, IPX4, or IPX7.

16. The applicator as in any one of claims 1-15, further comprising:

a manifold configured to hold a removable gel trap while the applicator is held against the subject and the temperature-controlled surface faces the subject's tissue,

wherein the treatment cup further comprises one or more air-egress features connected to the at least one vacuum port, wherein the at least one vacuum port extends from the tissue-receiving cavity to the manifold.

17. The applicator of claim 16, wherein the manifold is inside the housing and is fluidly coupled between the at least one vacuum port and a flexible connector coupled to the applicator.

18. The applicator as in any one of claims 1-17, wherein the treatment cup includes a plurality of air-egress channels extending from the at least one vacuum port and across the temperature-controlled surface to allow for removal of air pockets between the subject’s tissue and the temperature-controlled surface when the vacuum is provided.

19. The applicator as in any one of claims 1-18, wherein the treatment cup includes a network of branching air-egress features extending across most of a width and/or length of the tissue-receiving cavity.

20. The applicator as in any one of claims 1-19, further comprising:

a gel trap including:

a container configured to capture gel, and

at least one sealing member configured to sealingly engage the applicator to fluidically couple the at least one vacuum port and a vacuum line in the applicator such that the container captures gel drawn out of the tissue-receiving cavity while allowing sufficient air flow between the tissue-receiving cavity and the vacuum line to hold the subject's tissue against the temperature-controlled surface.

21. The applicator as in any one of claims 1-19, wherein the applicator is configured to hold a gel trap in fluid communication with the tissue-receiving cavity such that a reservoir of the gel trap is remote from the temperature-controlled surface.

22. The applicator as in any one of claim 1-19, further comprising a gel trap configured to hold the gel away from heat flow paths between the treatment cup and the subject's tissue.

23. The applicator as in any one of claims 1-19, further comprising a backside receiving feature configured to hold a gel trap viewable from a backside of the applicator.

24. The applicator as in any one of claims 1-19, further comprising a gel trap configured for toolless installation and/or toolless removal from the applicator.

25. The applicator as in any one of claims 1-19, further comprising:

a manifold; and

a gel trap that establishes a fluid tight connection with the manifold upon manual insertion of the gel trap into the manifold.

26. The applicator as in any one of claims 1-19, wherein:

the housing includes an upper housing portion and a lower housing portion;

the treatment cup is mounted in the upper housing portion; and

the lower housing portion includes an aperture allowing a gel trap to be inserted into and removed from a manifold fluidically coupled to the at least one vacuum port and a flexible connector coupled to the applicator.

27. The applicator as in any one of claims 1-19, further comprising:

a manifold fluidly coupled between the at least one vacuum port and a flexible connector coupled to the applicator; and

a gel trap installable in the manifold to capture substances drawn out of the treatment cup while permitting airflow between the at least one vacuum port and the flexible connector.

28. The applicator as in any one of claims 1-27, further comprising a contamination circuit configured to detect presence of fluid within the housing.

29. The applicator of claim 28, wherein the contamination circuit is configured to switch from an open state to a closed state when the presence of the fluid is detected.

30. The applicator as in any one of claims 1-27, further comprising:

at least one moisture detector configured to switch from an open state to a closed state upon contact with moisture; and

a controller in communication with the at least one moisture detector and programmed to identify the moisture in the housing based on one or more signals indicative that the at least one moisture detector switched from the open state to the closed state.

31. The applicator of claim 30, wherein the at least one moisture detector includes a plurality of moisture detectors each configured to detect the presence of freestanding liquid capable of contacting circuitry within the applicator.

32. The applicator as in any one of claims 1-31, further comprising an interconnect assembly configured to releasably couple the applicator to a flexible connector, wherein the interconnect assembly includes a supply fluid line fitting, a return fluid line fitting, a vacuum line fitting, and an electrical connector.

33. The applicator of claim 32, wherein one or more of the supply fluid line fitting, return fluid line fitting, or vacuum line fitting are dripless fittings.

34. The applicator as in any one of claims 1-33, further including:

an interconnect assembly including a vacuum line fitting and an electrical connector; and

a cap detachably coupleable to the interconnect assembly to cover the electrical connector and including a throughhole which fluidically couples to the vacuum line fitting.

~~35. An apparatus for treating a subject's tissue, comprising:~~

~~at least one heat-exchanger plate having a cooling surface;~~

~~at least one thermal unit thermally contacting the at least one heat-exchanger plate; and~~

~~a thermal feathering feature extending along at least a portion of a perimeter of the at least one heat-exchanger plate, wherein the thermal feathering feature is in thermal contact with the at least one thermal unit such that a peripheral cooling surface of the thermal feathering feature is warmer than the cooling surface so that the subject's tissue directly underlying the peripheral cooling surface is damaged or reduced but to a lesser extent than the subject's targeted tissue directly below and cooled by the cooling surface.~~

~~36. The apparatus of claim 35, wherein the thermal feathering feature is configured to produce a temperature gradient across the peripheral cooling surface that decreases toward a periphery of the apparatus.~~

37. The apparatus as in any one of claims 35-36, wherein the at least one heat-exchanger plate includes a plurality of interconnected and rotatable heat-exchanger plates surrounded by the thermal feathering feature.

38. The apparatus as in any one of claims 35-37, wherein the thermal feathering feature is configured to provide an amount of heat flow from the underlying tissue to the at least one thermal unit, wherein the amount of heat flow is substantially less than an amount of heat flow from the subject's targeted tissue directly below the cooling surface of the at least one thermal unit.

39. The apparatus as in any one of claims 35-38, wherein the thermal feathering feature absorbs heat to damage and/or reduce underlying lipid-rich cells in the subject's tissue while lipid-rich cells underlying the at least one heat-exchanger plate are damaged and/or reduced to a greater extent.

40. The apparatus as in any one of claims 35-39, wherein the thermal feathering feature is less thermally conductive than the at least one heat-exchanger plate to keep the peripheral cooling surface at least 3°C warmer than a temperature of the cooling surface when cooling the subject's targeted tissue to a temperature below 0°C.

41. A kit for treating a subject's tissue, comprising:

a plurality of applicators, each applicator including a treatment cup defining a tissue-receiving cavity and having a temperature-controlled surface configured to cool and selectively reduce the subject's tissue, wherein at least some of the applicators have different dimensions to treat differently-sized treatment sites; and

a connector configured to operably couple a single applicator to a control unit of a treatment system,

wherein each applicator includes an interconnect section configured to releasably couple the applicator to the connector.

42. The kit of claim 41, wherein the plurality of applicators includes at least two applicators having different treatment area to weight ratios.

43. The kit as in any one of claims 41-42, wherein the plurality of applicators includes at least two applicators having different treatment area to tissue-draw depth ratios.

44. The kit as in any one of claims 41-43, wherein the interconnect section is configured to couple to an interconnect receptacle of the connector.

45. The kit as in any one of claims 41-44, wherein the interconnect section includes a first locking feature, and the interconnect receptacle includes a second locking feature, the first and second locking features being configured as a bayonet connector.

46. The kit as in any one of claims 41-45, wherein the interconnect section is configured to mate with the interconnect receptacle when the applicator is rotated in a first direction, and wherein the interconnect section is configured to unmate from the interconnect receptacle when the applicator is rotated in a second, opposite direction.

47. The kit as in any one of claims 41-46, further comprising a plurality of applicator templates, each applicator template having dimensions corresponding to dimensions of a respective applicator of the plurality of applicators.

48. The kit as in any one of claims 41-46, wherein each applicator template comprises:

a frame having the dimensions corresponding to the dimensions of the respective applicator;

a handle configured to be held by a user; and

one or more connectors extending between the frame and the handle.

49. The kit as in any one of claims 41-48, wherein each applicator template includes one or more alignment features configured to facilitate positioning of the applicator template on a body region of the subject.

50. The kit as in any one of claims 41-49, wherein each of the applicator templates has a frame that is approximately geometrically congruent to a lip of the respective applicator of the plurality of applicators.

51. The kit as in any one of claims 41-50, further comprising a cap detachably couplable to each of the plurality of applicators to protect an electrical connector when internal fluid lines of the respective one of the plurality of applicators is flushed with fluid.

52. The kit as in any one of claims 41-51, further comprising a cap detachably couplable to an interconnect assembly of at least one of the plurality of applicators to protect an electrical connector of the interconnect assembly and allow flow fluid through a vacuum line fitting of the interconnect assembly.

53. A treatment system for cooling and selectively affecting a subject's tissue, comprising:

at least one applicator including a treatment cup configured to be in thermal communication with the subject's tissue; and

a control unit operably couplable to the at least one applicator, wherein the control unit includes:

a cooling unit configured to cool the treatment cup of the at least one applicator; and

at least one vacuum unit configured to apply a vacuum to the subject's tissue via the treatment cup, wherein the at least one vacuum unit is configured to reach a target vacuum pressure with at least one of (a) an amount of overshoot that is no more than 10% of the target pressure or (b) an amount of undershoot that is no more than 10% of the target pressure.

~~54. The treatment system of claim 53, wherein the cooling unit is configured to cool the treatment cup at a rate within a range from 0.2 °C/s to 3 °C/s.~~

~~55. The treatment system as in any one of claims 53-54, wherein the cooling unit has one or more of the following:~~

~~a transient heat removal rate greater than or equal to 200 W;~~

~~a steady state heat removal rate greater than or equal to 150 W; or~~

~~an efficiency greater than or equal to 75%.~~

~~56. The treatment system as in any one of claims 53-55 wherein a ratio of heat absorbed by the applicator from the subject's tissue to the heat actively removed from the applicator by the treatment system is equal to or greater than 0.7.~~

~~57. The treatment system as in any one of claims 53-56, wherein the cooling unit is configured to circulate a coolant to the applicator to remove heat from the applicator, and wherein a majority of the heat removed from the applicator originates from the subject's tissue.~~

~~58. The treatment system as in any one of claims 53-57, wherein the cooling unit comprises a variable speed compressor.~~

~~59. The treatment system as in any one of claims 53-58, further comprising at least one sensor configured to measure air flow, wherein the at least one vacuum unit is configured to draw a vacuum to fill the treatment cup based on output from the at least one sensor.~~

~~60. The treatment system as in any one of claims 53-59, wherein the at least one vacuum unit is configured to reach a target vacuum pressure in no more than 5 seconds.~~

~~61. The treatment system as in any one of claims 53-60, wherein a dampening ratio of the overshoot to the undershoot is within a range from 0.3 to 0.7.~~

62. The treatment system as in any one of claims 53-61, wherein the at least one vacuum unit is configured to maintain target pressure with a pressure drop of no more than 3 inHg for a flow rate of 15 LPM.

63. The treatment system as in any one of claim 53-62, wherein the at least one vacuum unit includes at least one sensor configured to generate flow measurements.

64. The treatment system as in any one of claim 53-63, wherein the at least one vacuum unit is configured to detect vacuum conditions associated with one or more of the following based on the flow measurements: pop off, pop on, or an improper seal between the at least one applicator and the subject's tissue.

65. The treatment system as in any one of claims 53-64, wherein the at least one vacuum unit is a single stage vacuum unit.

66. The treatment system as in any one of claims 53-65, wherein the control unit further comprises a fluid trap configured to prevent liquid from entering the at least one vacuum unit.

67. The treatment system of claim 66, wherein the fluid trap is located in the control unit.

68. The treatment system as in any one of claims 53-67, wherein the at least one applicator includes two or more applicators configured to be detachably coupled to the control unit, wherein the cooling unit is configured to receive and cool coolant from each of the two or more applicators.

69. The treatment system as in any one of claims 53-68, wherein the two or more applicators are configured to treat different regions of the subject's body.

~~70. The treatment system as in any one of claims 53-69, wherein the different regions include two or more of the following: an abdomen, a thigh, a buttock, a knee, a submental region, a face, or an arm.~~

~~71. The treatment system as in any one of claims 53-70, wherein the at least one vacuum unit includes two or more vacuum units, each vacuum unit being fluidly coupled to a respective applicator of the two or more applicators.~~

~~72. The treatment system as in any one of claims 53-71, wherein the two or more vacuum units are configured to operate independently of each other.~~

~~73. The treatment system as in any one of claims 53-72, wherein the control unit further includes at least one applicator controller operably coupled to the at least one applicator.~~

~~74. The treatment system of claim 73, wherein the at least one applicator controller is located away from the at least one applicator.~~

~~75. The treatment system as in any one of claims 73-74, wherein the at least one applicator controller is located in the control unit.~~

~~76. The treatment system as in any one of claims 73-75, wherein the at least one applicator controller is configured to control operation of one or more thermoelectric units located in the at least one applicator.~~

~~77. The treatment system as in any one of claims 73-76, wherein the at least one applicator controller is configured to control the operation of each thermoelectric unit independently.~~

~~78. The treatment system as in any one of claim 73-77, wherein the at least one applicator controller is configured to control the operation of the thermoelectric unit using a PID algorithm.~~

79. The treatment system of claim 78, wherein input data for the PID algorithm includes one or more of the following: an amount of power delivered to the thermoelectric unit, an amount of power delivered to one or more other thermoelectric units, a temperature of the thermoelectric unit, a temperature of the one or more other thermoelectric units, and/or a temperature of the subject's tissue.

80. The treatment system as in any one of claims 53-79, wherein the at least one applicator controller is configured to perform an anti-freeze process comprising:

detecting freezing of a skin surface using one or more temperature sensors located near the skin surface; and

heating the skin surface to a target temperature using the one or more thermoelectric units.

81. The treatment system of claim 80, wherein the skin surface is heated to a target temperature greater than or equal to 5 °C within no more than 30 seconds after detection of skin freezing.

82. The treatment system as in any one of claims 53-81, wherein the at least one applicator controller is configured to receive temperature data from one or more thermistors.

83. The treatment system as in any one of claims 53-82, further comprising at least one connector configured to releasably couple the at least one applicator to the control unit.

84. The treatment system of claim 83, wherein the at least one connector comprises a proximal end section configured to releasably couple to the control unit via a first bayonet connection, a distal end section configured to releasably couple to the at least one applicator via a second bayonet connection, and a flexible cable extending between the proximal end section and the distal end section.

~~85. The treatment system of claim 84, wherein the distal end section includes a first interconnect receptacle having a first cavity shaped to receive a distal interconnect assembly of the at least one applicator, and wherein the proximal end section includes a second interconnect receptacle having a second cavity shaped to receive an interconnect mount secured to the control unit.~~

~~86. The treatment system of claim 84, wherein the distal end section is configured to be coupled to and decoupled from the at least one applicator with a maximum axial force of no more than 10 lb and a maximum rotational torque of no more than 15 lbf, and wherein the proximal end section is configured to be coupled to and decoupled from the control unit with a maximum axial force of no more than 10 lb and a maximum rotational torque of no more than 15 lbf.~~

~~87. The treatment system as in any one of claims 53-86, wherein the control unit includes a power unit configured to receive power from an external power source having a line voltage of any of 100, 120, 200, 220, or 240 volts.~~

~~88. The treatment system of claim 87, wherein the power unit includes a transformer circuit configured to automatically detect the line voltage from the external power source and convert the line voltage to one or more system voltages.~~

~~89. The treatment system as in any one of claims 53-88, wherein the control unit further comprises a card reader configured to obtain information from a card, wherein the control unit is programmed to allow the treatment system to perform a treatment based on the card including at least one treatment credit.~~

~~90. The treatment system as in any one of claims 53-89, further comprising a card storing information that includes one or more of the following:~~

~~credits for treatment cycles,~~
~~treatment parameters,~~
~~anti-tampering software,~~
~~patient information,~~
~~a territory limit.~~

~~91. The treatment system as in any one of claims 53-90, further comprising a card programmed to enable credits to be added to the card so long as one unused credit is on the card.~~

~~92. The treatment system as in any one of claims 53-90, further comprising a card which contains a credit that allows the control unit to allow the treatment system to perform two independent treatments.~~

~~93. The treatment system as in any one of claims 91-92, wherein the card allows the control unit to allow the treatment system to perform the two treatments simultaneously using two applicators.~~

~~94. The treatment system of claim 93, wherein the card contains a further credit that allows the control unit to allow the treatment system to perform a single treatment using a single applicator.~~

~~95. The treatment system as in any one of claims 53-94, further comprising a card that contains credits to allow for any applicator compatible with the treatment system to be enabled for treatment using the card.~~

~~96. The treatment system as in any one of claims 90-95, wherein the card is constructed such that when no credits remain, the card is automatically locked to prevent future treatments using the card.~~

~~97. The treatment system as in any one of claim 53-96, wherein the at least one applicator has a vacuum-based tissue retention factor greater than 5 square inches per lb.~~

~~98. The treatment system of claim 97, wherein the vacuum-based tissue retention factor is configured such that the at least one applicator remains secured to the subject only via the applied vacuum.~~

99. A gel trap for fluidically coupling a vacuum line to a tissue-receiving cavity of an applicator, the gel trap comprising:

a container configured to capture gel, and

at least one sealing member configured to sealingly engage the applicator to fluidically couple the vacuum line to a vacuum port of the applicator such that the container captures gel drawn out of the tissue-receiving cavity while allowing air flow between the tissue-receiving cavity and the vacuum line to hold a subject's tissue in the tissue-receiving cavity.

100. The gel trap of claim 99, wherein

the container includes a mouth with the inlet and a main body with an outlet, and

the at least one sealing member includes:

a first sealing member coupled to the mouth and configured to form an airtight seal with the applicator such that the mouth is fluidically coupled to the vacuum port; and

a second sealing member coupled to the main body and configured to form an airtight seal with the applicator such that the outlet is fluidically coupled to the vacuum line.

101. The gel trap of claim 99, wherein the at least one sealing member includes a compressible member configured to form an air-tight seal with the applicator when the gel trap is installed in the applicator.

102. The gel trap as in any one of claims 99-101, further comprising one or more air-permeable, gel-impermeable membranes extending across the outlet.

103. A method for cleaning a vacuum applicator configured to hold and cool a subject's tissue to reduce subcutaneous lipid-rich cells, comprising:

coupling a cap to the vacuum applicator such that the cap protects an electrical connector and fluidically couples a throughhole of the cap to a vacuum line of the vacuum applicator; and

delivering liquid through the vacuum line of the vacuum applicator such that the

~~liquid flows through the vacuum line and the throughhole.~~

~~104. The method of claim 103, wherein the cap fluidically couples the vacuum line to an exterior environment.~~

~~105. The method as in any one of claims 103-104, wherein the cap is removably coupled to an interconnect assembly of the applicator.~~

~~106. The method as in any one of claims 103-105, wherein the cap hermetically seals the electrical connector from an exterior environment.~~