precise ultrasound to cause a visible and effective cosmetic results via a thermal pathway by using band shaped treatment focus zone techniques to expand the area and volume of tissue treated at a specific, targeted area.

According to a first aspect of the present invention, there is provided an ultrasound transduction system, including: a cylindrical transduction element; and a power source configured to drive the cylindrical transduction element, wherein the cylindrical transduction element is configured to apply ultrasonic energy to a linear focal zone at a focal depth, wherein the cylindrical transduction element comprises a first surface and a second surface, wherein the first surface comprises an electrically conductive coating fully covering the first surface, wherein the second surface comprises two electrically conductive coated regions and at least one region that is not coated with an electrically conductive coating, wherein the two coated regions on the second surface comprises a conductive material that forms an electrode when the power source is in electric communication with the at least one coated region, wherein the conductive material comprises any one or more of the group consisting of: silver, copper, gold, and chrome; wherein the coated regions on the second surface cover at least 60% of the second surface; wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge; wherein the two coated regions on the second surface is configured to reduce edge noise at the linear focal zone at the focal depth, wherein the reduction of edge noise reduces any one of the group consisting of: a peak such that a variance around the focal depth is reduced by 75 – 200%, a peak such that a variance of an intensity around the focal depth is 5 mm or less, and a variance in focal gain in a range of 0.01 – 10.

According to a second aspect of the present invention, there is provided a non-invasive, cosmetic method of heating tissue with a cylindrical ultrasound transducer, including: providing a cylindrical transduction element comprising a first surface, a second surface, a coated region, and an uncoated region, wherein the coated region comprises an electrical conductor fully covering the first surface, wherein the first surface comprises at least one coated region, wherein the conductive material comprises any one or more of the group consisting of: silver, copper, gold, and chrome; wherein the coated regions on the second surface cover at least 60% of the second surface; wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge; wherein the second surface comprises the uncoated region and a plurality of coated regions, applying a current to the coated region, thereby directing ultrasound energy to a linear focal zone at a focal depth, wherein the ultrasound energy produces a reduction in focal gain at the linear focal zone wherein the reduction of focal gain reduces any one of the group consisting of: a peak such that a variance around the focal depth is reduced by 25 – 200%, a peak such that a variance of an intensity around the focal depth is 5 mm or less, and a variance in focal gain in a range of 0.01 – 10.

According to a third aspect of the present invention, there is provided a cosmetic heating system for use in non-invasive, cosmetic method of heating tissue, the cosmetic heating system including:

a hand-held probe, wherein the hand-held probe comprises a housing that encloses an ultrasound transducer configured to heat tissue below the skin surface to a tissue temperature in the range of 40 – 50 degrees Celsius, wherein the ultrasound transducer comprises a cylindrical transduction element comprising a first surface, a second surface, a coated region, and an uncoated region, wherein the coated region comprises an electrical conductor fully covering the first surface, wherein the first surface comprises at least one coated region, wherein the coated regions on the second surface cover at least 60% of the second surface, wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge, wherein the second surface comprises the uncoated region and a plurality of coated regions, wherein the cosmetic heating system is configured to apply a current to the plurality of coated regions, thereby directing ultrasound energy to a linear focal zone at a focal depth, wherein the ultrasound energy produces a reduction in focal gain at the linear focal zone, thereby heating the tissue at the focal depth in the linear focal zone to the tissue temperature in the range of 40 – 50 degrees Celsius for a cosmetic treatment duration of less than 1 hour, thereby reducing a volume of an adipose tissue in the tissue.

Treatment can include heating, coagulation, and/or ablation (including, for example, hyperthermia, thermal dosimetry, apoptosis, and lysis). In various embodiments, band treatment provides improved thermal heating and treatment of tissue compared to diathermy or general bulk heating techniques. In various embodiments, band treatment provides the capability of heating and/or treating tissue at specific depth ranges without affecting proximal tissues. In general, diathermy and bulk heating techniques usually involve heating a skin surface and conducting the heat through the skin surface and all underlying tissue to reach a tissue at a target depth below the skin surface. In various embodiments, band treatment provides targeted heating and treatment at a specific, prescribed depth range below the skin surface without heating the skin surface and/or intermediary tissue between the skin surface and the target tissue. This offset band treatment reduces damage and associated pain at the skin surface, and treats tissue only at the prescribed, targeted tissue depth. Thus, embodiments of the present invention can be used to treat tissue in a specific range of depths below the skin surface without heating the skin surface. In some embodiments, band treatment can also be used to prepare tissue at target depths for a second, ultrasound treatment by pre-heating the target tissue to an elevated temperature so the secondary treatment can be performed with reduced time and/or energy and increased comfort.

[0005] In accordance with various embodiments, a cosmetic ultrasound treatment system and/or method can non-invasively produce single or multiple cosmetic treatment zones and/or thermal treatment points, lines, bands, belts, planes, areas, volumes, and/or shapes, where ultrasound is focused in one or more locations in a region of treatment in tissue at one or more depths under a skin surface. Some systems and methods provide cosmetic treatment at different locations in tissue, with treatment areas at various depths, heights, widths, and/or positions. In one embodiment, a method and system comprise a transducer system configured for providing ultrasound treatment to more than one region of interest, such as between at least two treatment positions and/or regions of interest. In one embodiment, a method and system comprise a transducer system configured for providing

CLAIMS

1. An ultrasound transduction system, comprising:

a cylindrical transduction element; and

a power source configured to drive the cylindrical transduction element,

wherein the cylindrical transduction element is configured to apply ultrasonic energy to a linear focal zone at a focal depth,

wherein the cylindrical transduction element comprises a first surface and a second surface,

wherein the first surface comprises an electrically conductive coating fully covering the first surface,

wherein the second surface comprises two electrically conductive coated regions and at least one region that is not coated with an electrically conductive coating,

wherein the two coated regions on the second surface comprises a conductive material that forms an electrode when the power source is in electric communication with the at least one coated region,

wherein the conductive material comprises any one or more of the group consisting of: silver, copper, gold, and chrome;

wherein the coated regions on the second surface cover at least 60% of the second surface;

wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge;

wherein the two coated regions on the second surface is configured to reduce edge noise at the linear focal zone at the focal depth,

wherein the reduction of edge noise reduces any one of the group consisting of:

a peak such that a variance around the focal depth is reduced by 75 – 200%,

a peak such that a variance of an intensity around the focal depth is 5 mm or less, and

a variance in focal gain in a range of 0.01 – 10.

2. The ultrasound transduction system according to claim 1, further comprising one or more imaging elements, wherein the cylindrical transduction element has an opening configured for placement of the one or more imaging elements,

wherein the cylindrical transduction element is housed within an ultrasonic hand-held probe, wherein the ultrasonic probe comprises:

a housing,

the cylindrical transduction element, and

a motion mechanism;

wherein the ultrasound transducer is movable within the housing,

wherein the motion mechanism is attached to the ultrasound transducer and configured to move the ultrasound transducer along a linear path within the housing.

wherein the conductive material is silver,

wherein the first surface is a concave surface and the second surface is a convex surface.

3. The ultrasound transduction system according to claim 1, wherein the first surface is a concave surface and the second surface is a convex surface.

4. The ultrasound transduction system according to claim 1, wherein the first surface is a convex surface and the second surface is a concave surface.

5. The ultrasound transduction system according to claim 1, wherein the cylindrical transduction element is housed within an ultrasonic hand-held probe, wherein the ultrasonic probe comprises:

a housing,

the cylindrical transduction element, and

a motion mechanism;

wherein the ultrasound transducer is movable within the housing,

wherein the motion mechanism is attached to the ultrasound transducer and configured to move the ultrasound transducer along a linear path within the housing.

6. The ultrasound transduction system according to claim 5, wherein the motion mechanism automatically moves the cylindrical transduction element to heat a treatment area at the focal depth to a temperature in a range between 40 – 65 degrees Celsius.

7. The ultrasound transduction system according to any one of claims 1 - 6, wherein the reduction of edge noise facilitates the production of a uniform temperature in a treatment area.

8. The ultrasound transduction system according to any one of claims 1 - 6, wherein the reduction of edge noise facilitates the efficient and consistent treatment of a tissue, wherein the cylindrical transduction element is configured to apply ultrasonic therapy to a treatment zone at the focal depth in the tissue.

9. The ultrasound transduction system according to any one of claims 1 - 6, wherein the power source is configured to drive the cylindrical transduction element to produce a temperature in a range of 42 – 55 degrees Celsius in a tissue at the focal depth.

10. The ultrasound transduction system according to any one of claims 2 - 6, further comprising a temperature sensor located on the housing proximate an acoustic window in the housing configured to measure a temperature at a skin surface.

11. The ultrasound transduction system according to any one of claims 1 and 3 - 6, further comprising one or more imaging elements, wherein the cylindrical transduction element has an opening configured for placement of the one or more imaging elements.

12. The ultrasound transduction system according to claim 11, wherein the imaging element is configured to confirm a level of acoustic coupling between the system and a skin surface.

13. The ultrasound transduction system according to claim 11, wherein the imaging element is configured to confirm a level of acoustic coupling between the system and a skin surface via any one of the group consisting of: defocused imaging and Voltage Standing Wave Ratio (VSWR).

14. The ultrasound transduction system according to claim 11, wherein the imaging element is configured to measure a temperature at a target tissue at the focal depth below a skin surface.

15. The ultrasound transduction system according to claim 11, wherein the imaging element is configured to measure a temperature at a target tissue at the focal depth below a skin surface with any one of the group of Acoustic Radiation Force Impulse (ARFI), Shear Wave Elasticity Imaging (SWEI), and measurement of attenuation.

16. A non-invasive, cosmetic method of heating tissue with a cylindrical ultrasound transducer, comprising:

providing a cylindrical transduction element comprising a first surface, a second surface, a coated region, and an uncoated region,

wherein the coated region comprises an electrical conductor fully covering the first surface,

wherein the first surface comprises at least one coated region,

wherein the conductive material comprises any one or more of the group consisting of: silver, copper, gold, and chrome;

wherein the coated regions on the second surface cover at least 60% of the second surface;

wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge;

wherein the second surface comprises the uncoated region and a plurality of coated regions,

applying a current to the coated region, thereby directing ultrasound energy to a linear focal zone at a focal depth,

wherein the ultrasound energy produces a reduction in focal gain at the linear focal zone,

wherein the reduction of focal gain reduces any one of the group consisting of:

a peak such that a variance around the focal depth is reduced by 25 – 200%,

a peak such that a variance of an intensity around the focal depth is 5 mm or less, and

a variance in focal gain in a range of 0.01 – 10.

17. The method according to claim 16, wherein the reduction of focal gain facilitates the efficient and consistent treatment of tissue, wherein the cylindrical transduction element is configured to apply ultrasonic therapy to a thermal treatment zone at a focal depth.

18. The method according to claim 16, wherein the reduction of focal gain reduces a peak such that a variance around the focal depth is reduced by 25 – 100%.

19. The method according to claim 16, wherein the electrical conductor is a metal.

20. The method according to claim 16, wherein the first surface is a concave surface and the second surface is a convex surface.

21. The method according to claim 16, wherein the first surface is a convex surface and the second surface is a concave surface.

22. The method according to any one of claims 16 - 21, wherein the cylindrical transduction element is housed within an ultrasonic hand-held probe, wherein the ultrasonic probe comprises:

a housing,

the cylindrical transduction element, and

a motion mechanism;

wherein the ultrasound transducer is movable within the housing,

wherein the motion mechanism is attached to the ultrasound transducer and configured to move the ultrasound transducer along a linear path within the housing.

23. The method according to claim 22, wherein the motion mechanism automatically moves the cylindrical transduction element to a treatment area.

24. The method according to any one of claims 16 - 21, further comprising imaging tissue with one or more imaging elements, wherein the cylindrical transduction element has an opening configured for placement of the one or more imaging elements.

25. The method according to claim 24, further comprising confirming a level of acoustic coupling between the system and a skin surface with an image from the imaging element.

26. The method according to claim 24, further comprising confirming a level of acoustic coupling between the system and a skin surface with the imaging element using any one of the group consisting of: defocused imaging and Voltage Standing Wave Ratio (VSWR).

27. The method according to claim 24, further comprising measuring a temperature at a target tissue at the focal depth below a skin surface with the imaging element.

28. The method according to claim 24, further comprising measuring a temperature with the imaging element at a target tissue at the focal depth below a skin surface with any one of the group of Acoustic Radiation Force Impulse (ARFI), Shear Wave Elasticity Imaging (SWEI), and measurement of attenuation.

29. A cosmetic heating system for use in non-invasive, cosmetic method of heating tissue, the cosmetic heating system comprising:

a hand-held probe,

wherein the hand-held probe comprises a housing that encloses an ultrasound transducer configured to heat tissue below the skin surface to a tissue temperature in the range of 40 – 50 degrees Celsius,

wherein the ultrasound transducer comprises a cylindrical transduction element comprising a first surface, a second surface, a coated region, and an uncoated region,

wherein the coated region comprises an electrical conductor fully covering the first surface,

wherein the first surface comprises at least one coated region,

wherein the coated regions on the second surface cover at least 60% of the second surface,

wherein the coated regions on the second surface comprise a lateral edge, a medial edge, a first side edge, and a second side edge,

wherein the second surface comprises the uncoated region and a plurality of coated regions,

wherein the cosmetic heating system is configured to apply a current to the plurality of coated regions, thereby directing ultrasound energy to a linear focal zone at a focal depth,

wherein the ultrasound energy produces a reduction in focal gain at the linear focal zone,

thereby heating the tissue at the focal depth in the linear focal zone to the tissue temperature in the range of 40 – 50 degrees Celsius for a cosmetic treatment duration of less than 1 hour,

thereby reducing a volume of an adipose tissue in the tissue.

30. The cosmetic heating system according to claim 29, wherein the reduction of focal gain facilitates the efficient and consistent treatment of tissue, wherein the cylindrical transduction element is configured to apply ultrasonic therapy to a thermal treatment zone at a focal depth.

31. The cosmetic heating system according to claim 29, wherein the reduction of focal gain reduces a peak such that a variance around the focal depth is reduced by 25 – 100%.

32. The cosmetic heating system according to claim 29, wherein the reduction of focal gain reduces a peak such that a variance of an intensity around the focal depth is 5 mm or less.

33. The cosmetic heating system according to claim 29, wherein the reduction of focal gain reduces a variance in focal gain in a range of 0.01 – 10.

34. The cosmetic heating system according to claim 29, wherein the electrical conductor is a metal.

35. The cosmetic heating system according to claim 29, wherein the first surface is a concave surface and the second surface is a convex surface.

36. The cosmetic heating system according to claim 29, wherein the first surface is a convex surface and the second surface is a concave surface.

37. The cosmetic heating system according to any one of claims 29 - 36, wherein the cylindrical transduction element is housed within an ultrasonic hand-held probe, wherein the ultrasonic probe comprises:

a housing,

the cylindrical transduction element, and

a motion mechanism;

wherein the ultrasound transducer is movable within the housing,

wherein the motion mechanism is attached to the ultrasound transducer and configured to move the ultrasound transducer along a linear path within the housing.

38. The cosmetic heating system according to claim 37, wherein the motion mechanism automatically moves the cylindrical transduction element to heat a treatment area at the focal depth to a temperature in a range between 40 – 42 degrees Celsius.

39. The cosmetic heating system according to any one of claims 29 - 36, wherein the cylindrical transduction element produces a temperature in a range of 42 – 50 degrees Celsius in a tissue at the focal depth.

40. The cosmetic heating system according to any one of claims 29 - 36, further comprising imaging tissue with one or more imaging elements, wherein the cylindrical transduction element has an opening configured for placement of the one or more imaging elements.

41. The cosmetic heating system according to claim 40, further comprising confirming a level of acoustic coupling between the system and a skin surface with an image from the imaging element.

42. The cosmetic heating system according to claim 40, further comprising confirming a level of acoustic coupling between the system and a skin surface with the imaging element

using any one of the group consisting of: defocused imaging and Voltage Standing Wave Ratio (VSWR).

43. The cosmetic heating system according to claim 40, further comprising measuring a temperature at a target tissue at the focal depth below a skin surface with the imaging element.

44. The cosmetic heating system according to claim 40, further comprising measuring a temperature with the imaging element at a target tissue at the focal depth below a skin surface with any one of the group of Acoustic Radiation Force Impulse (ARFI), Shear Wave Elasticity Imaging (SWEI), and measurement of attenuation.