Claims

What is claimed is:

1. An ultrasound transducer, comprising:

a multi-layered membrane comprising a plurality of slits extending through the membrane, thereby forming a plurality of sections of the membrane at least partially separated by the slits;

wherein each slit is a spiral shaped slit, and extends spirally from a perimeter of the membrane to a respective end position at a predetermined distance away from a center of the membrane,

wherein the plurality of sections of the membrane are connected to each other at the center of the membrane.

2. The ultrasound transducer of claim 1,

wherein the plurality of slits extend through the membrane along a direction at least substantially perpendicular to the membrane.

3. The ultrasound transducer of claim 1,

wherein a tangent at the end portion of each slit is through the center of the membrane.

4. The ultrasound transducer of claim 1,

wherein the center of the membrane is a center of gravity of the membrane.

5. The ultrasound transducer of claim 1,

wherein the multi-layered membrane is a disc-shaped membrane.

6. The ultrasound transducer of claim 1,

wherein the multi-layered membrane is clamped around at least a portion of the perimeter.

7. The ultrasound transducer of claim 1,

wherein each slit has a width in a range of 0.1% - 15% of a radius of the multi-layered membrane.

8. The ultrasound transducer of claim 1,

wherein a length of each slit is in a range of 10% - 90% of a radius of the multi-layered membrane.

9. The ultrasound transducer of claim 1,

wherein the multi-layered membrane comprises a substrate, a first electrode layer arranged on the substrate, a piezoelectric layer arranged on the first electrode layer, and a second electrode layer arranged on the piezoelectric layer.

10. The ultrasound transducer of claim 9,

wherein at least one of the first electrode layer and the second electrode layer comprises an inner circle portion and an outer ring portion separated by a gap.

11. The ultrasound transducer of claim 9,

wherein the multi-layered membrane is patterned such that a diameter of the substrate is larger than a diameter of the first electrode layer, the diameter of the first electrode layer is larger than a diameter of the piezoelectric layer, and the diameter of the piezoelectric layer is larger than a diameter of the second electrode layer.

12. The ultrasound transducer of claim 1, wherein the multi-layered membrane comprises:

a first electrode layer,

a second electrode layer,

a third electrode layer,

a first piezoelectric layer arranged inbetween the first electrode layer and the second electrode layer, and

a second piezoelectric layer arranged inbetween the second electrode layer and the third electrode layer,

wherein the second electrode layer is arranged inbetween the first piezoelectric layer and the second piezoelectric layer.

13. The ultrasound transducer of claim 12,

wherein at least one of the first electrode layer and the third electrode layer comprises an inner circle portion and an outer ring portion separated by a gap.

14. The ultrasound transducer of claim 1,

wherein one or more layers of the multi-layered membrane are configured to have various thicknesses and diameters, thereby providing various resonant frequencies of the multi-layered membrane.

15. A method of forming an ultrasound transducer, the method comprising:

providing a multi-layered membrane; and

forming a plurality of slits extending through the membrane, thereby forming a plurality of sections of the membrane at least partially separated by the slits;

wherein each slit is a spiral shaped slit, and extends spirally from a perimeter of the membrane to a respective end position at a predetermined distance away from a center of the membrane,

wherein the plurality of sections of the membrane are connected to each other at the center of the membrane.

16. The method of claim 15, further comprising:

forming a first electrode layer on a substrate;

forming a piezoelectric layer on the first electrode layer;

forming a second electrode layer on the piezoelectric layer, thereby forming the multi-layered membrane; and

forming the plurality of slits extending through the first electrode layer, the piezoelectric layer and the second electrode layer.

17. The method of claim 15, further comprising:

forming a first electrode layer on a substrate;

forming a first piezoelectric layer on the first electrode layer;

forming a second electrode layer on the first piezoelectric layer;

forming a second piezoelectric layer on the second electrode layer;

forming a third electrode layer on the second piezoelectric layer, thereby forming the multi-layered membrane;

forming the plurality of slits extending through the first electrode layer, the first piezoelectric layer, the second electrode layer, the second piezoelectric layer and the third electrode layer; and

removing a selected area of the substrate to expose the first electrode layer from a bottom surface of the first electrode layer.

18. The method of claim 17, further comprising at least one of:

etching a portion of the first electrode layer to form an inner circle portion and an outer ring portion of the first electrode layer; or

etching a portion of the third electrode layer to form an inner circle portion and an outer ring portion of the third electrode layer.