CLAIMS

1. An acoustic transducer comprising:

a substrate comprising a cavity extending from a surface of the substrate, wherein the substrate further comprises one or more acoustic channels, each of the one or more acoustic channels having a depth extending from the surface of the substrate and a length, the length greater than the depth, extending at least partially around the cavity; and

a layered arrangement suspended over the cavity;

wherein the layered arrangement comprises a membrane stack and a transducer stack over the membrane stack, the transducer stack forming a first resonant unit;

wherein the substrate comprises a beam wall to at least partially define the cavity and the one or more acoustic channels, the beam wall separating the cavity from the one or more acoustic channels, the beam wall forming a second resonant unit coupled to the first resonant unit; and

wherein the one or more acoustic channels comprise an acoustic medium having a specific acoustic impedance lower than a specific acoustic impedance of the substrate, the acoustic medium being any one selected from a group consisting of a solid and a liquid, the one or more acoustic channels with the acoustic medium forming a third resonant unit coupled to the first resonant unit or the second resonant unit.

2. The acoustic transducer according to claim 1,

wherein the one or more acoustic channels comprising the acoustic medium provide amplification to an initial acoustic transmit signal generated by the membrane stack upon application of a voltage to the transducer stack.

3. The acoustic transducer according to claim 1,

wherein the one or more acoustic channels comprising the acoustic medium provide amplification to an initial electrical signal generated by the transducer stack upon an ultrasound wave incident onto the membrane stack.

4. The acoustic transducer according to claim 1,
wherein an end portion of the beam wall is in contact with the membrane stack.

5. The acoustic transducer according to claim 1,
wherein the beam wall is configured to vibrate in a flexural mode upon application of an excitation voltage.

6. The acoustic transducer according to claim 1,
wherein the acoustic medium is the solid; and
wherein the solid is polyimide or polydimethylsiloxane.

7. The acoustic transducer according to claim 1,
wherein the acoustic medium is the liquid; and
wherein the liquid is water or alcohol.

8. The acoustic transducer according to claim 1,
wherein an effective stiffness of the acoustic medium is lower than an effective stiffness of the layered arrangement and an effective stiffness of the substrate.

9. The acoustic transducer according to claim 1,
wherein the depth of each of the one or more acoustic channels further extends through the layered arrangement.

10. The acoustic transducer according to claim 1,
wherein the acoustic transducer is a piezoelectric micromachined acoustic transducer or a capacitive micromachined acoustic transducer.

11. The acoustic transducer according to claim 1,

wherein the transducer stack has a cross-sectional shape selected from a group consisting of a square, a circle, an annulus, a polygon, and an ellipse.

12. The acoustic transducer according to claim 1,

wherein the one or more acoustic channels form a shape selected from a group consisting of a square, a circle, a pentagon, and a hexagon.

13. The acoustic transducer according to claim 1,

wherein the transducer stack comprises:

a first electrode;

a second electrode; and

a piezoelectric layer between the first electrode and the second electrode.

14. The acoustic transducer according to claim 1,

wherein the layered arrangement comprises:

a first dielectric layer;

a second dielectric layer; and

a membrane layer between the first dielectric layer and the second dielectric layer.

15. The acoustic transducer according to claim 1,

wherein a relative frequency shift between a resonant frequency of a transducer unit, the transducer unit including the layered arrangement and the cavity, and a resonant frequency of the one or more acoustic channels is within 30% of the resonant frequency of the transducer unit; or

wherein a 6dB bandwidth of the transducer unit and a 6dB bandwidth of the one or more acoustic channels overlap more than 80%.

16. The acoustic transducer according to claim 1,

wherein a relative frequency shift between a resonant frequency of a transducer unit, the transducer unit including the layered arrangement and the cavity, and

a resonant frequency of the one or more acoustic channels is more than 30% but within 60% of the resonant frequency of the transducer unit; or
wherein a 6dB bandwidth of the transducer unit and a 6dB bandwidth of the one or more acoustic channels overlap more than 30% but less than 80%.

17. A method of forming an acoustic transducer, the method comprising:
patterning a substrate such that the substrate comprises a cavity extending from a surface of the substrate, wherein the substrate further comprises one or more acoustic channels, each of the one or more acoustic channels having a depth extending from the surface of the substrate and a length, the length greater than the depth, extending at least partially around the cavity; and
forming a layered arrangement suspended over the cavity;
wherein the layered arrangement comprises a membrane stack and a transducer stack over the membrane stack, the transducer stack forming a first resonant unit;
wherein the substrate comprises a beam wall to at least partially define the cavity and the one or more acoustic channels, the beam wall separating the cavity from the one or more acoustic channels, the beam wall forming a second resonant unit coupled to the first resonant unit; and

wherein the one or more acoustic channels comprise an acoustic medium having a specific acoustic impedance lower than a specific acoustic impedance of the substrate, the acoustic medium being any one selected from a group consisting of a solid and a liquid, the one or more acoustic channels with the acoustic medium forming a third resonant unit coupled to the first resonant unit or the second resonant unit.