CLAIMS

1. An apparatus comprising:

at least one optical waveguide;

a plurality of whispering gallery mode (WGM) resonators, each WGM resonator configured to propagate a first set of whispering gallery modes (WGMs); and

a polymer structure encapsulating the at least one optical waveguide and at least one WGM resonator of the plurality of WGM resonators,

wherein the at least one WGM resonator is optically coupled to the at least one optical waveguide such that the at least one WGM resonator is configured to communicate to the at least one optical waveguide a first set of signals corresponding to the first set of WGMs.

2. The apparatus of claim 1, wherein the polymer structure comprises at least one of:

a backing region configured to attenuate residual ultrasound echoes to prevent reverberation, and

a matching region configured to increase a bandwidth of a WGM frequency response of the plurality of WGM resonators.

3. The apparatus of claim 2, wherein the matching region is further configured to improve ultrasound transmission to the plurality of WGM resonators.

4. The apparatus of claim 3, wherein at least one of the backing region and the matching region has a first refractive index lower than a second refractive index of the at least one optical waveguide.

5. The apparatus of claim 2, wherein the at least one optical waveguide is embedded in the backing region of the polymer structure.

6. The apparatus of claim 2, wherein the at least one optical waveguide is embedded in the matching region of the polymer structure.

7. The apparatus of claim 2, wherein the at least one WGM resonator is embedded in the matching region of the polymer structure.

8. The apparatus of claim 1, wherein an effective refractive index of the polymer structure is lower than a refractive index of the at least one WGM resonator.

9. The apparatus of claim 1, wherein the polymer structure comprises an ultrasonic enhancement material.

10. The apparatus of claim 1, wherein an effective acoustic impedance of the polymer structure matches an acoustic impedance of the at least one WGM resonator.

11. The apparatus of claim 1, wherein the at least one WGM resonator comprises at least one of a microsphere and a microbubble.

12. The apparatus of claim 1, wherein the at least one WGM resonator is configured to:
receive a plurality of ultrasound echoes; and
in response to the plurality of ultrasound echoes, propagate a second set of WGMs.

13. The apparatus of claim 12, wherein the at least one WGM resonator is further configured to communicate to the at least one optical waveguide a second set of signals corresponding to the second set of WGMs.

14. The apparatus of claim 13, further comprising an optical detector communicably coupled to the at least one optical waveguide, wherein the at least one optical waveguide is configured to propagate the first set of signals and the second set of signals to the optical detector.

15. The apparatus of claim 1, wherein the at least one optical waveguide comprises an optical fiber or an integrated photonic waveguide.

16. The apparatus of claim 1, wherein the at least one optical waveguide is coupled to a light source.

17. The apparatus of claim 16, wherein the light source comprises a broadband light source or a tunable laser source.

18. The apparatus of claim 1, wherein the at least one WGM resonator comprises a hollow chamber.

19. The apparatus of claim 18, wherein the hollow chamber includes an ultrasonic enhancement material.

20. The apparatus of claim 1, each WGM resonator of the plurality of WGM resonators is optically coupled to the at least one optical waveguide.

21. The apparatus of claim 1, wherein the at least one optical waveguide comprises a plurality of optical waveguides, and each WGM resonator of the plurality of WGM resonators is optically coupled to a respective optical waveguide of the plurality of optical waveguides.

22. The apparatus of claim 1, wherein at least a portion of the WGM resonators are grouped in a linear arrangement.

23. The apparatus of claim 22, wherein the WGM resonators in the linear arrangement are equally spaced apart.

24. The apparatus of claim 22, wherein the WGM resonators in the linear arrangement are unequally spaced apart.

25. The apparatus of claim 1, wherein the plurality of WGM resonators are bundled in a circular arrangement.

26. The apparatus of claim 1, wherein at least a portion of the WGM resonators are equal sizes.

27. The apparatus of claim 1, wherein at least a portion of the WGM resonators are unequal sizes.

28. A system comprising the apparatus of claim 12 and a plurality of array elements configured to generate a set of ultrasound signals, wherein the plurality of ultrasound echoes correspond to the set of ultrasound signals.

29. The system of claim 28, wherein the array elements comprise at least array element selected from the group consisting of: a piezoelectric sensor, a single crystal material sensor, a piezoelectric micromachined ultrasound transducer (PMUT), and a capacitive micromachined ultrasound transducer sensor (CMUT).

30. A method of ultrasound imaging comprising:

receiving, from at least one optical waveguide, a first set of signals corresponding to a first set of whispering gallery modes (WGMs) propagating in a plurality of WGM resonators, wherein the at least one optical waveguide and the plurality of WGM resonators are in a polymer structure;

receiving, from the at least one optical waveguide, a second set of signals corresponding to a second set of WGMs propagating in the plurality of WGM resonators, the second set of WGMs propagating in response to the plurality of WGM resonators receiving a plurality of ultrasound echoes; and

detecting a set of differences between the first set of signals and the second set of signals.

31. An apparatus comprising:

a whispering gallery mode (WGM) resonator configured to propagate a set of WGMs, wherein the WGM resonator comprises a curved surface,

wherein the curved surface comprises a first spherical segment corresponding to a first mode of the WGM resonator and a second spherical segment corresponding to a second mode of the WGM resonator, wherein the second mode is of higher frequency than the first mode, and

wherein the second spherical segment is covered with a polymer configured to attenuate the second mode.

32. A method for making a whispering gallery mode (WGM) resonator, the method comprising:

providing a WGM resonator comprising a curved surface, wherein the curved surface comprises a first spherical segment corresponding to a first mode of the WGM resonator and a second spherical segment corresponding to a second mode of the WGM resonator, wherein the second mode is of a frequency different from the first mode;

covering the second spherical segment with a polymer configured to attenuate the second mode.