CLAIMS

What is claimed is:

1. A method of fabricating an acoustic transducer for generation and/or detection of acoustic waves for structural health monitoring, the method comprising:

in-situ direct-writing of a piezoelectric material to create a piezoelectric layer on a structure to be monitored; and

in-situ direct-writing of at least one conductive electrode for the piezoelectric layer as an electrode.

2. The method of claim 1 wherein the at least one conductive electrode is on top of the piezoelectric layer to act as a top electrode.

3. The method of claim 1 wherein the piezoelectric material is a polymer and wherein the step of in-situ direct-writing of the piezoelectric material comprises in-situ spraying of a precursor solution of the polymer.

4. The method of claim 1 wherein the step of direct-writing of the piezoelectric material comprises one of depositing the piezoelectric layer on a surface of the structure conforming to a contour of the surface of the structure to be monitored or aerosol spraying of the piezoelectric material through a patterned mask directly onto the structure to be monitored.

5. The method of claim 2 further comprising the step of patterning the top electrode to form an annular array comb electrode such that concentric arcs are formed with one common trace connecting all the arcs.

6. The method of claim 5 wherein the step of patterning the top electrode to form an annular array comb electrode comprises forming the annular array comb electrode with a period, wherein the period is a distance between each arc, and wherein the period corresponds to an excitation frequency of a mode of a Lamb mode ultrasonic wave in the piezoelectric material.

7. The method of claim 5 wherein the step of patterning the top electrode to form an annular array comb electrode comprises forming the annular array comb electrode substantially at a corner of a portion of the structure with a spanning angle facing away from the corner.

8. The method of claim 1 wherein the step of in-situ direct-writing of the piezoelectric material comprises inkjet printing of the piezoelectric material directly onto the structure to be monitored.

9. The method of claim 2 further comprising the step of depositing a protective layer over the top electrode.

10. The method of claim 2 wherein the structure is conductive and the structure functions as a bottom electrode.

11. The method of claim 2 further comprising the step of in-situ direct-writing a bottom electrode intermediate between the structure to be monitored and the piezoelectric layer.

12. A system with an acoustic transducer for structural health monitoring, comprising:

a structure to be monitored having one or more of a flat surface and a curved surface thereon;

a layer of piezoelectric material on top of a portion of the structure; and

a layer of electrode for the piezoelectric material layer, wherein the layer of electrode is patterned, and wherein the layer of piezoelectric material and the layer of electrode form an acoustic transducer for generating and detecting acoustic waves in the structure to be monitored for identifying defects in the structure to be monitored.

13. The system of claim 12 wherein the layer of electrode is on top of the piezoelectric layer to act as a top electrode.

14. The system of claim 12, wherein the acoustic waves comprise a Lamb mode ultrasonic wave for identifying defects in the structure to be monitored, wherein the layer of electrode is in the

form of an annular array comb such that the concentric arcs are formed with one common trace connecting all the arcs, and the annular array comb electrode is patterned with a period, the period being a distance between each arc, and wherein the period corresponds to an excitation frequency of the Lamb mode ultrasonic wave.

15. The system of claim 14 further comprising a plurality of the acoustic transducers wherein each of the plurality of the acoustic transducers has annular array comb electrodes positioned substantially at a corner of a portion of the structure with a spanning angle facing away from the corner.

16. A method for structural health monitoring comprising the step of forming a plurality of acoustic transducers on a structure to be monitored, wherein each of the plurality of acoustic transducers comprises a layer of piezoelectric material direct-written on top of the structure and a layer of electrode direct-written on top of the piezoelectric material layer, wherein at least a first one and a second one of the plurality of acoustic transducers are formed across a portion of the structure, and wherein the first one and the second one of the plurality of acoustic transducers are configured to generate and detect an acoustic wave in the portion of the structure to obtain structural health information.

17. The method of claim 16 wherein a subset of the plurality of acoustic transducers including the first one and the second one of the plurality of acoustic transducers are arranged around a periphery of the portion of the structure, the method further comprising the steps of:

the first one of the plurality of acoustic transducers generating the acoustic wave in the portion of the structure;

the second one of the plurality of acoustic transducers detecting the acoustic wave in the portion of the structure; and

comparing a first electrical signal of the acoustic wave detected by the second one of the plurality of acoustic transducers on the portion of the structure when the portion of the structure is in a pristine condition with a second electrical signal of the acoustic wave detected by the second one of the plurality of acoustic transducers on the structure at a structural health

monitoring time to determine if the obtained structural health information indicates formation of a defect in the portion of the structure

18. The method of claim 17 wherein the step of comparing the first and second electrical signals of the acoustic wave detected by the second one of the plurality of acoustic transducers comprises comparing a shift in time of the first and second electrical signals in a time domain to determine a type of defect in the structure.

19. The method of claim 17 wherein the step of comparing the first and second electrical signals of the acoustic wave detected by the second one of the plurality of acoustic transducers comprises comparing amplitudes of the first and second electrical signals to determine a location, a size or a severity of the defect in the structure.

20. The method of claim 17 further comprising the step of actuating each of the plurality of the plurality of acoustic transducers arranged around the periphery of the portion of the structure individually to generate an acoustic wave in the portion of the structure in such a way that when one of the plurality of acoustic transducers is actuated to generate the acoustic wave in the structure, the remaining ones of the plurality of acoustic transducers detect the acoustic wave in the structure.