CLAIMS

1. A method of monitoring a surface defect on a proximal wall of a structure, comprising:

transmitting a generated ultrasonic bulk wave from an ultrasonic transducer array disposed on the proximal wall, the generated ultrasonic bulk wave being transmitted from the proximal wall as a spread wave having a central line angularly displaced relative to the proximal wall; and

determining at least one characteristic of the surface defect based on a reflected ultrasonic bulk wave sensed by the ultrasonic transducer array, the ultrasonic transducer array being disposed on the proximal wall and disposed to one side of the surface defect.

2. The method as recited in claim 1, comprising:

determining at least one characteristic of the surface defect based on respective arrival times of the reflected ultrasonic bulk wave sensed by at least two ultrasonic transducers selected from the ultrasonic transducer array.

3. The method as recited in claim 2, comprising:

determining one or both of the following:

a depth of the surface defect based on the respective arrival times of the reflected ultrasonic bulk wave; and

a distance between the surface defect and the ultrasonic transducers based on the respective arrival times of the reflected ultrasonic bulk wave.

4. The method as recited in claim 1, wherein the reflected ultrasonic bulk wave comprises a twice reflected ultrasonic bulk wave that is twice reflected at a distal wall of the structure, wherein the distal wall opposes the proximal wall.

5. The method as recited in claim 1, wherein the generated ultrasonic bulk wave is propagated along a path comprising in sequential order:

a transmission from the proximal wall;

a first reflection at a distal wall of the structure, the distal wall opposing the proximal wall;

a diffraction at the surface defect tip; and

a second reflection at the distal wall to form a twice reflected ultrasonic wave receivable at the ultrasonic transducer array at the respective arrival times.

6. The method as recited in claim 5, further comprising disposing the array of ultrasonic transducers longitudinally spaced apart from the surface defect with the at least two ultrasonic transducers being disposed on a same side of the surface defect.

7. The method as recited in claim 6, wherein the ultrasonic transducer array comprises a plurality of ultrasonic transducers aligned and evenly spaced apart from one another to form a two-dimensional array characterized by a regular pattern.

8. A device for monitoring a surface defect on a proximal wall of a structure, comprising:

an ultrasonic transducer array, the ultrasonic transducer array including a plurality of ultrasonic transducers spaced apart from one another, the ultrasonic transducer array being disposed on the proximal wall and oriented to transmit a generated ultrasonic bulk wave from the proximal wall as a spread wave having a central line angularly displaced relative to the proximal wall; and

a processor, the processor being operably coupled to the ultrasonic transducer array, the processor being configured to determine at least one characteristic of the surface defect based on a twice reflected ultrasonic bulk wave sensed by at least two selected from the plurality of ultrasonic transducers, wherein the ultrasonic transducer array is longitudinally spaced apart from the surface defect, and wherein the processor is configured to determine the at least one characteristic of the surface defect based on respective arrival times of the reflected ultrasonic bulk wave.

9. The device as recited in claim 8, wherein the at least one characteristic comprises any one or more of the following: a depth of the surface defect, a distance between the surface defect and a first selected ultrasonic transducer, and a presence of the surface defect, and wherein the processor is configured to simultaneously determine a depth of the surface defect and determine a distance between the surface defect and a first selected ultrasonic transducer based on the respective arrival times of the reflected ultrasonic bulk wave sensed by at least two ultrasonic transducers selected from the ultrasonic transducer array.

10. The device as recited in claim 8, wherein the twice reflected ultrasonic bulk wave comprises a twice reflected ultrasonic bulk wave reflected at a distal wall of the structure, and wherein the distal wall opposes the proximal wall.

11. The device as recited in claim 10, wherein the reflected ultrasonic bulk wave comprises a diffracted ultrasonic bulk wave at the surface defect tip.

12. The device as recited in claim 8, wherein the ultrasonic transducer array is characterized by a detectable range to detect a twice reflected ultrasonic wave, and wherein the twice reflected ultrasonic wave is characterized by a propagation path comprising in sequential order:

a transmission from the proximal wall;

a first reflection at a distal wall of the structure, the distal wall opposing the proximal wall;

a diffraction at the surface defect tip; and

a second reflection at the distal wall to form the twice reflected ultrasonic wave receivable at the ultrasonic transducer array at the respective arrival times.

13. The device as recited in claim 12, wherein each of the plurality of ultrasonic transducers is characterized by one of the following: a circular shape and a strip-like shape.

14. The device as recited in claim 13, wherein each of the plurality of ultrasonic transducers is characterized by a length-to-width ratio greater than 3.

15. The device as recited in claim 12, wherein the plurality of ultrasonic transducers are in-situ fabricated on the structure.