CLAIMS

What is claimed is:

1. An influenza detector for detecting a targeted influenza virus, the influenza detector comprising:

a liquid environment;

a surface acoustic wave (SAW) sensor in contact with the liquid environment; and

a targeted bioactive influenza species immobilized on a surface of the SAW sensor for selectively capturing an analyte for the targeted influenza virus,

wherein the SAW sensor comprises:

a substrate comprising a piezoelectric material for producing a surface acoustic wave signal in response to an applied electric field; and

an insulative layer formed on top of the substrate and having a functionalized surface formed thereon for selectively immobilizing the targeted bioactive influenza species, the functionalized surface being in contact with the liquid environment, and

wherein the surface acoustic wave signal produced by the SAW sensor changes in response to the analyte for the targeted influenza virus being present in the liquid environment and being captured by the targeted bioactive influenza species immobilized on the functionalized surface of the insulative layer of the SAW sensor.

2. The influenza detector in accordance with Claim 1 wherein the targeted influenza virus is influenza A virus.

3. The influenza detector in accordance with Claim 1 wherein the piezoelectric material is a ferroelectric material with a dielectric constant greater than fifty at a working frequency of the surface acoustic wave signal.

4. The influenza detector in accordance with Claim 1 wherein the SAW sensor further comprises a two-port delay line formed on the substrate into a pair of electrode-width single-phase unidirectional transducers, and wherein the surface acoustic wave signal comprises an in-plane mode surface acoustic wave signal which changes in response to the presence of the analyte for Influenza A virus in the liquid environment, the change comprising a phase shift of a radio frequency (RF) range S_{21} S-parameter.

5. The influenza detector in accordance with Claim 4 wherein a minimum width of electrodes of each of the pair of electrode-width single-phase unidirectional transducers is 1/8 of a wavelength of the surface acoustic wave signal.

6. The influenza detector in accordance with Claim 4 wherein the in-plane mode surface acoustic wave signal comprises a Love mode wave signal, and wherein the insulative layer formed on the top of the substrate functions as a waveguide.

7. The influenza detector in accordance with Claim 2 wherein the bioactive influenza species immobilized at the functionalized surface of the insulative layer is an antibody of the Influenza A virus and the analyte is a corresponding antigen of the Influenza A virus.

8. The influenza detector in accordance with Claim 7 wherein the antibody is a hemagglutinin (HA) antibody of the Influenza A virus and the analyte is a corresponding HA antigen of the Influenza A virus.

9. The influenza detector in accordance with Claim 7 wherein the antibody is a nucleoprotein (NP) antibody of the Influenza A virus and the analyte is a corresponding NP antigen of the Influenza A virus.

10. The influenza detector in accordance with any of Claims 7 to 9 wherein the functionalized surface of the insulative layer comprises silane molecules for selectively immobilizing the targeted bioactive Influenza A species.

11. The influenza detector in accordance with Claim 10 wherein the silane molecules are triethoxysilylbutylaldehyde (ALTES).

12. The influenza detector in accordance with Claim 1 further comprising a liquid chamber for containing the liquid environment, the liquid chamber coupled to inlet and outlet fluid tubing for passing a supply of a liquid sample through the liquid environment, the liquid sample possibly including the analyte for the targeted influenza virus.

13. The influenza detector in accordance with Claim 12 wherein the liquid chamber includes the functionalized surface of the insulative layer and a PDMS (polydimethylsiloxane) cover.

14. The influenza detector in accordance with Claim 1 wherein mechanical energy is applied to the SAW sensor for mechanically rupturing nonspecific bonds with the functionalized surface thereby improving sensor selectivity of the SAW sensor.

15. The influenza detector in accordance with Claim 14 wherein the mechanical energy is provided to the functionalized surface by the surface acoustic wave signal excited by applying the electric field to the SAW sensor.

16. The influenza detector in accordance with Claim 14 wherein the mechanical energy is provided to the liquid environment by an electromechanical transducer physically contacting the SAW sensor.

17. The influenza detector in accordance with any of the preceding claims wherein the SAW sensor has a sensor sensitivity resolution of one ng/ml or below.

18. The influenza detector in accordance with Claim 1 further comprising an electrical circuit coupled to the SAW sensor for applying the electric field to the piezoelectric material of the substrate.

19. The influenza detector in accordance with Claim 18, the electrical circuit comprising a phase shift measurement circuit with an additional reference line for thermal compensation.

20. A surface acoustic wave (SAW) sensor for Influenza A virus detection in liquid, the SAW sensor comprising:

a piezoelectric material for producing an in-plane mode surface acoustic wave signal in response to an electric field; and

an insulative layer formed on top of the piezoelectric material and having a functionalized surface formed thereon for selectively immobilizing a targeted bioactive influenza species for capturing an analyte for the Influenza A virus in the liquid.

21. The SAW sensor for Influenza A virus detection in liquid in accordance with Claim 20 wherein the insulative layer formed on top of the piezoelectric material has a silane-functionalized surface formed thereon for selectively immobilizing a targeted bioactive influenza species for capturing HA antigen as an analyte for the Influenza A virus in the liquid.

22. The SAW sensor for Influenza A detection in liquid in accordance with Claim 21 wherein the piezoelectric materials comprises a ferroelectric material with a high dielectric constant.

23. The SAW sensor for Influenza A detection in liquid in accordance with Claim 22 wherein the dielectric constant of the ferroelectric material is greater than fifty at a working frequency of the SAW sensor.

24. The SAW sensor for Influenza A detection in liquid in accordance with Claim 21 further comprising a two-port delay line formed on the substrate into a pair of electrode-width single-phase unidirectional transducers.

25. The SAW sensor for Influenza A detection in liquid in accordance with Claim 24 wherein a minimum electrode width of the unidirectional transducers is 1/8 of a wavelength of the surface acoustic wave signal.

26. The SAW sensor for Influenza A detection in liquid in accordance with either Claim 24 or Claim 25 wherein a gap between the pair of unidirectional transducers is 1/8 of a wavelength of the surface acoustic wave signal.

27. The SAW sensor for Influenza A detection in liquid in accordance with Claim 21 wherein the piezoelectric material produces the in-plane mode surface acoustic wave signal with S_{21} S-parameter phase shift changes in a RF range in response to presence of the analyte for the Influenza A virus in the liquid.

28. The SAW sensor for Influenza A detection in liquid in accordance with Claim 21 wherein the in-plane mode surface acoustic wave comprises a Love mode wave and the insulative layer formed on the top of the piezoelectric material functions as a waveguide.

29. The SAW sensor for Influenza A detection in liquid in accordance with Claim 20 wherein mechanical energy is applied to the functionalized surface for mechanically rupturing nonspecific bonds to improve sensor selectivity of the SAW sensor.

30. The SAW sensor for Influenza A detection in liquid in accordance with Claim 29 wherein the mechanical energy is provided through the surface acoustic wave signal excited in the SAW sensor.

31. The SAW sensor for Influenza A detection in liquid in accordance with Claim 29 wherein the mechanical energy is provided through use of an electromechanical transducer physically contacting the SAW sensor.