What is Claimed:

1. A sensor comprising:

a resonant transducer configured to determine a composition of an emulsion.

2. The sensor of claim 1 wherein the resonant transducer comprises a resonator configured to measure a full impedance spectrum of the resonant transducer associated with the emulsion.

3. The sensor of claim 1 wherein the resonant transducer is a two-dimensional resonant transducer.

4. The sensor of claim 1 wherein the resonant transducer is a three-dimensional resonant transducer.

5. The sensor claim 4 wherein the three-dimensional resonant transducer comprises:

a sampling cell;

a top winding disposed around an upper portion of the sampling cell; and

a bottom winding disposed around a lower portion of the sampling cell.

6. The sensor of claim 5 comprising a radio frequency absorber disposed around the top winding and the bottom winding.

7. The sensor of claim 6 further comprising a metal shield disposed around the radio frequency absorber.

8. The sensor of claim 7 further comprising a cover disposed around the metal shield.

9. The sensor of claim 5 further comprising an absorber of electromagnetic radiation disposed around the top winding and the bottom winding where the absorber absorbs electromagnetic radiation in the kilohertz, megahertz, gigahertz, and terahertz

frequency ranges depending on the operation frequency of the three-dimensional resonant transducer and the potential source of interferences.

10. The sensor of claim 5 further comprising an absorber of electromagnetic radiation disposed around the top winding and the bottom winding where the absorber is a combination of individual layers for particular frequency ranges.

11. A sensor comprising a resonant transducer, the resonant transducer being configured to simultaneously determine concentration of a first and a second component of an emulsion.

12. The sensor of claim 11 wherein the resonant transducer is configured to measure a resonance spectrum of a real impedance of the emulsion.

13. The sensor of claim 11 wherein the resonant transducer is configured to measure at least three data points of an impedance spectrum of the resonant transducer.

14. The sensor of claim 11 wherein the resonant transducer comprises a sensing region that detects changes in capacitance and resistance of the resonant transducer.

15. The sensor of claim 11 wherein the resonant transducer is selected from among a group consisting of a one-dimensional resonant transducer, a two-dimensional resonant transducer, and a three-dimensional resonant transducer.

16. The sensor of claim 11 wherein the resonant transducer comprises a sensing region that detects changes in capacitance, resistance, inductance of the resonant transducer.

17. The sensor of claim 11 where the resonant transducer is configured to probe an environment over a sample depth perpendicular to the resonant transducer of between 0.1 mm to 1,000 mm.

18. The sensor of claim 17 where effects of sensor fouling are reduced by signal processing of an impedance spectrum.

19. The sensor of claim 17 where effects of sensor fouling are reduced by transducer geometry related to a penetration depth of an electric field into the emulsion.

20. A sensor system comprising:

a resonant transducer configured to determine a composition of an emulsion;

a sampling assembly; and

an impedance analyzer.

21. The sensor system of claim 20 wherein the resonant transducer comprises a resonator configured to measure a set of LCR resonant circuit parameters.

22. The sensor system of claim 21 wherein the set of LCR resonant circuit parameters comprise at least one of an impedance spectrum, a real part of the impedance spectrum, an imaginary part of an impedance spectrum, both real and imaginary parts of the impedance spectrum, a frequency of a maximum of the real part of a complex impedance, a magnitude of the real part of the complex impedance, a resonant frequency, a magnitude of the imaginary part of the complex impedance, and an anti-resonant frequency and a magnitude of the imaginary part of the complex impedance.

23. The sensor system of claim 20 wherein the resonant transducer comprises a dielectric layer of a thickness between 2 nm to 50 cm.

24. The sensor system of claim 21 wherein the impedance analyzer converts the set of LCR resonant circuit parameters to values of a complex impedance spectrum.

25. A sensor system for determining a composition of a mixture of oil and water in a vessel comprising:

a subsystem that determines a set of complex impedance spectrum values of the of oil at one end of the vessel and the water at the opposite end with a resonant transducer;

a subsystem that generates calibration values for the sensor system for 100% oil and 100% water, respectively;

a subsystem that generates a model from the calibration values; and

a subsystem that applies the model to the set of complex impedance spectrum values to determine the composition.

Claims

1. A sensor comprising:

an electrically resonant transducer comprised of a top winding and a bottom winding, said bottom winding coupled at opposite ends across a capacitor, wherein said top winding provides excitation and detection of the bottom winding, wherein mutual inductance of the top winding is used to sense the bottom winding, said mutual inductance used to measure values of real and imaginary parts of an impedance spectra of the bottom winding across said capacitor and said top winding, said impedance spectra determined from an electrical response of the bottom winding to the top winding of the electrically resonant transducer while said bottom winding is proximate to an emulsion and said measured values of real and imaginary parts of the impedance spectra of the bottom winding are each independently used to determine a composition of the emulsion.

2. The sensor of claim 1 further comprising a sampling cell, wherein the top winding of the electrically resonant transducer is disposed around an upper portion of the sampling cell; and the bottom winding of the electrically resonant transducer is disposed around a lower portion of the sampling cell.

3. The sensor of claim 2, further comprising a radio frequency absorber disposed around the top winding and the bottom winding.

4. The sensor of claim 3 further comprising a metal shield disposed around the radio frequency absorber.

5. The sensor of claim 4 further comprising a cover disposed around the metal shield.

6. The sensor of claim 2 further comprising an absorber of electromagnetic radiation disposed around the top winding and the bottom winding where the absorber absorbs electromagnetic radiation in kilohertz, megahertz, gigahertz, and terahertz frequency ranges depending on the operation frequency of the electrically resonant transducer and a source of interferences.

7. The sensor of claim 2 further comprising an absorber of electromagnetic radiation disposed around the top winding and the bottom winding where the absorber is a combination of individual layers for particular frequency ranges.

8. The sensor of claim 1, wherein the measured values for the real and the imaginary parts of the impedance spectra are each independently used to simultaneously determine a concentration of a first and a second component of the emulsion.

9. The sensor of claim 8 wherein the electrically resonant transducer measures at least three data points of the real and the imaginary parts of the impedance spectra of the electrically resonant transducer.

10. The sensor of claim 8 wherein the electrically resonant transducer comprises a sensitive portion that detects changes in capacitance and resistance of the electrically resonant transducer.

11. The sensor of claim 8 wherein the electrically resonant transducer comprises a sensitive portion that detects changes in capacitance, resistance, inductance of the electrically resonant transducer.

12. The sensor of claim 8 where the electrically resonant transducer probes an environment over a sample depth perpendicular to the electrically resonant transducer of between 0.1 mm to 1,000 mm.

13. The sensor of claim 1, wherein the electrically resonant transducer measures a set of LCR resonant circuit parameters, said set of LCR resonant circuit parameters comprise at least one of an impedance spectrum, a real part of the impedance spectrum, an imaginary part of the impedance spectrum, both a real part and an imaginary part of the impedance spectrum, a frequency associated with a maximum of the real part of a complex impedance, a magnitude of the real part of the complex impedance, a resonant frequency, a magnitude of imaginary part of the complex

impedance, and an anti-resonant frequency and a magnitude of the imaginary part of the complex impedance.