CLAIMS

1. A method for making an in situ measurement of downhole fluid properties at a subterranean well, comprising the steps of:
    a. deploying an electromechanical resonator at the subterranean well such that an electromechanical resonator is at least partially immersed in a downhole fluid;
    b. causing the electromechanical resonator to oscillate at a resonance frequency by powering an oscillator circuit, wherein the electromechanical resonator is incorporated as a frequency-defining element of the oscillator circuit, and wherein the oscillator circuit comprises a closed loop circuit;
    c. measuring the resonance frequency of the oscillation produced by the oscillator circuit;
    d. measuring a damping of the oscillation produced by the oscillator circuit; and
    e. relating the frequency and the damping to a viscosity and a density of the downhole fluid by employing a processor configured by code to utilize at least one of:
        i. theoretical equations relating frequency and damping to fluid viscosity and density; and
        ii. empirical relationships based on curve fitting to calibration measurements of the resonance frequency and damping in reference fluids, wherein the viscosity and density of such fluids are known.
2. The method of claim 1, further comprising the steps of
    a. repeating the method of claim one to obtain measurements in at least two locations at the subterranean well;
    b. determining temperature and pressure at the locations where density and viscosity are determined; and
    c. searching a family of similar fluids where density and viscosity have been measured for a range of pressure and temperature values to identify the fluid or combination of fluids which has density and viscosity values most similar to those measured at the subterranean well for the pressures and temperatures where measurements were taken at the subterranean well.
3. A method for determining properties of a downhole fluid, comprising the steps of:
    a. exposing an electromechanical resonator which is part of an oscillator circuit to an uncharacterized downhole fluid, the electromechanical resonator having driving and sensing functions, and the oscillator circuit comprising:
        i. an amplifier having an output and an input;

ii. a feedback loop between the output and input of the amplifier; and

iii. the electromechanical resonator disposed within the feedback loop such that a resonant frequency of the electromechanical resonator defines the oscillation frequency of the oscillator circuit, wherein the oscillator circuit comprises a closed loop circuit;

b. activating the oscillator circuit such that the electromechanical resonator reaches the resonant frequency in the uncharacterized fluid;

c. measuring the period of the oscillation of the electromechanical resonator;

d. determining an energy loss parameter of the electromechanical resonator in the uncharacterized fluid; and

e. calculating at least one property of the uncharacterized fluid by reference to the energy loss parameter and the period of the oscillator circuit, wherein a parasitic capacitance of the electromechanical resonator is cancelled by using a reference capacitor and a signal subtraction circuit and wherein a constant oscillation amplitude is maintained via an automatic gain adjustment circuitry or a negative resistance control system.

4. The method of claim 3 wherein the electromechanical resonator geometry is one of: a cantilever, a tuning fork, a vibrating wire, and an oscillating plate.
5. The method of claim 3 wherein the electromechanical resonator is actuated into at least one vibrational mode selected from: in-plane, out-of-plane, torsional, scissoring, pivoting, and higher order mode.
6. The method of claim 3, wherein the driving and sensing functions are decoupled.
7. The method of claim 6, wherein the driving and sensing functions are decoupled by relying on different physical effects selected from: electrical, magnetic, mechanical and optical domains.
8. The method of claim 6, wherein the driving and sensing functions are decoupled by physical separation of the driving and sensing locations.
9. The method of claim 3, wherein the uncharacterized fluid is located downhole, and further comprising the step of disposing the oscillator circuit downhole.
10. The method of claim 3, further comprising the step of determining flow rates for each phase in a multiphase flow.
11. The method of claim 3, wherein a viscosity of the fluid is determined by exposing the electromechanical resonator to fluid at a depth within a well before the fluid is brought to a surface.

12. The method of claim 3, wherein the electromechanical resonator is housed in a chamber and a portion of the uncharacterized downhole fluid is selectively drawn into the chamber and separated and/or conditioned, chemically or physically, to perform the measuring step.
13. The method of claim 3, wherein the uncharacterized downhole fluid can comprise at least one of a fluid, dispersed fluid-fluid, solid-fluid, or gas-fluid system and wherein properties of the phase diagram of the uncharacterized downhole fluid are inferred from viscosity and density changes and their dependence on pressure, temperature, volume, or concentration of the dispersed phase.
14. The method of claim 3, wherein the electromechanical resonator is selectively coated to change its affinity to the uncharacterized downhole fluid or a chemical.
15. The method of claim 3, wherein the oscillator circuit is supported by a wireline tool capable of making measurements at multiple points in a well.
16. The method of claim 3, wherein the oscillator circuit is supported by an untethered sensor platform capable of making measurements at multiple points in a well.
17. The method of claim 3, further comprising the step of determining a composition of the fluid, wherein the fluid is a multiphase flow.