A Micro Electro Mechanical System (MEMS), for the Measurement of the Complex Relative Permittivity: Results for Methylbenzene, Octane, Argon, and an Ionic Liquid at Temperatures between 323 and 423 K and Pressures in the Range 0.1 to 68 MPa

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Reservoir fluids can contain water, mixtures of hydrocarbons, in both the liquid and gas phases, and other inorganic species that are often dissolved in the hydrocarbon liquid. The discrimination of the type of fluid and phase as a function of position within the formation are significant for the successful economic development. Measurements of the complex relative electric permittivity provide a means for fluid and phase identification. A MicroElectroMechanical-System (MEMS) has been constructed to measure the complex relative permittivity of fluids. This device has four capacitors formed from four boron doped silicon resistors that are interconnected with vapor deposited aluminum wire to form a Wheatstone bridge. Two of the capacitors, which form the active elements, are exposed to the fluid while the other two are deposited atop the mono-crystalline silicon-on-insulator wafer. The capacitiance of the fluid is measured relative to that of the two arms embedded in silicon. With this arrangement, the fluid electric permittivity is determined relative to that of silicon. Capacitances were determined with an Andeen-Hagerling ratio transformer bridge at a frequency of 1 kHz A resistor, formed from boron doped amorphous silicon, was used as the thermometer. Measurements were performed with methylbenzene, octane, and argon at temperature in the range 323 to 423 K at pressure below 68 MPa. The measurements were used to verify the operation of these devices before determining the relative electric permittivity of an ionic liquid.