CLAIMS

The invention claimed is:

1. A system, comprising:

a flow path provided within a wellbore and containing a fluid in which a chemical reaction is taking place, wherein the fluid comprises at least one of a reagent and a product associated with the chemical reaction;

at least one integrated computational element arranged in an optical train to optically interact with the fluid in the flow path and thereby generate optically interacted light, the at least one integrated computational element comprising a plurality of thin film layers deposited on an optical substrate;

at least one detector arranged in the optical train following the at least one integrated computational element to receive the optically interacted light and generate an output signal corresponding to a characteristic of the chemical reaction occurring within the fluid; and

a signal processor communicably coupled to the at least one detector for receiving the output signal, the signal processor being programmed to determine the characteristic of the chemical reaction based on the output signal.

2. The system of claim 1, further comprising an electromagnetic radiation source arranged in the optical train, the electromagnetic radiation source emitting electromagnetic radiation that optically interacts with at least one of the at least one integrated computational element and the fluid.

3. The system of claim 1, wherein the characteristic of the chemical reaction is a concentration of the reagent in the fluid and the signal processor is further programmed to determine the concentration of the reagent in the fluid.

4. The system of claim 3, wherein the reagent in the fluid comprises at least one substance selected from the group consisting of barium, calcium, manganese, sulfur, iron, strontium, chlorine, paraffins, waxes, asphaltenes, aromatics, saturates, foams, salts, particulates, sand, and any combinations thereof.

5. The system of claim 3, wherein the reagent in the fluid comprises at least one substance selected from the group consisting of acids, acid-generating compounds, bases, base-generating compounds, biocides, surfactants, scale inhibitors, corrosion inhibitors, gelling agents, crosslinking agents, anti-sludging agents, foaming agents, defoaming agents, antifoam agents, emulsifying agents, de-emulsifying agents, iron control agents, particulate diverters, salts, fluid loss control additives, gases, catalysts, clay control agents, chelating agents, corrosion inhibitors, dispersants, flocculants, scavengers, lubricants, breakers, delayed release breakers, friction reducers, bridging agents, viscosifiers, weighting agents, solubilizers, rheology control agents, viscosity modifiers, pH control agents, hydrate inhibitors, relative permeability modifiers, diverting agents, consolidating agents, fibrous materials, bactericides, tracers, probes, nanoparticles, tetrakis hydroxymethyl phosphonium sulfate (THPS), glutaraldehyde, benzalkonium chloride, algal/fungal/bacterial deposits, imidazoline derivatives, quaternary ammonium salts, alkaline zinc carbonate, amines, and any combinations thereof.

6. The system of claim 1, wherein the characteristic of the chemical reaction is a concentration of the product resulting from the chemical reaction and the signal processor is further programmed to determine the concentration of the product resulting from the chemical reaction.

7. The system of claim 1, wherein the signal processor is further programmed to determine the characteristic of the chemical reaction when the characteristic of the chemical reaction comprises at least one substance selected from the group consisting of a chemical composition, an impurity content, a pH level, a temperature, a viscosity, a density, an ionic strength, a total dissolved solids measurement, a salt content measurement, a porosity, an opacity measurement, a bacteria content, and any combinations thereof.

8. The system of claim 1, further comprising an electromagnetic radiation source arranged in the optical train and emitting electromagnetic radiation, wherein the at least one detector is a first detector and the system further comprises a second detector arranged to detect the electromagnetic radiation and thereby generate a compensating signal indicative of electromagnetic radiating deviations.

9. The system of claim 8, wherein the signal processor communicably coupled to the first and second detectors, the signal processor being programmed to receive and computationally combine the output and compensating signals in order to normalize the output signal.

10. The system of claim 1, wherein the flow path comprises at least one structure selected from the group consisting of a flowline, a storage vessel, a separator, a contactor, a process vessel, and any combinations thereof.

CLAIMS

The invention claimed is:

1. A system, comprising:

a flow path provided downhole and containing a fluid in which a chemical reaction is taking place, wherein the fluid comprises at least one of a reagent and a product associated with the chemical reaction;

at least one integrated computational element arranged in an optical train to optically interact with the fluid in the flow path and thereby generate optically interacted light, the at least one integrated computational element comprising a plurality of layers deposited on an optical substrate;

at least one detector arranged in the optical train following the at least one integrated computational element to receive the optically interacted light and generate an output signal corresponding to a characteristic of the chemical reaction occurring within the fluid; and

a signal processor communicably coupled to the at least one detector for receiving the output signal, the signal processor being programmed to determine the characteristic of the chemical reaction based on the output signal.

2. The system of claim 1, further comprising an electromagnetic radiation source arranged in the optical train, the electromagnetic radiation source emitting electromagnetic radiation that optically interacts with at least one of the at least one integrated computational element and the fluid.

3. The system of claim 1, wherein the characteristic of the chemical reaction is a concentration of the reagent in the fluid and the signal processor is further programmed to determine the concentration of the reagent in the fluid.

4. The system of claim 3, wherein the reagent in the fluid comprises at least one substance selected from the group consisting of barium, calcium, manganese, sulfur, iron, strontium, chlorine, paraffins, waxes, asphaltenes, aromatics, saturates, foams, salts, particulates, sand, and any combinations thereof.

5. The system of claim 3, wherein the reagent in the fluid comprises at least one substance selected from the group consisting of acids, acid-generating compounds, bases, base-generating compounds, biocides, surfactants, scale inhibitors, corrosion inhibitors, gelling agents, crosslinking agents, anti-sludging agents, foaming agents, defoaming agents, antifoam agents, emulsifying agents, de-emulsifying agents, iron control agents, particulate diverters, salts, fluid loss control additives, gases, catalysts, clay control agents, chelating agents, corrosion inhibitors, dispersants, flocculants, scavengers, lubricants, breakers, delayed release breakers, friction reducers, bridging agents, viscosifiers, weighting agents, solubilizers, rheology control agents, viscosity modifiers, pH control agents, hydrate inhibitors, relative permeability modifiers, diverting agents, consolidating agents, fibrous materials, bactericides, tracers, probes, nanoparticles, tetrakis hydroxymethyl phosphonium sulfate (THPS), glutaraldehyde, benzalkonium chloride, algal/fungal/bacterial deposits, imidazoline derivatives, quaternary ammonium salts, alkaline zinc carbonate, amines, and any combinations thereof.

6. The system of claim 1, wherein the characteristic of the chemical reaction is a concentration of the product resulting from the chemical reaction and the signal processor is further programmed to determine the concentration of the product resulting from the chemical reaction.

7. The system of claim 1, wherein the signal processor is further programmed to determine the characteristic of the chemical reaction when the characteristic of the chemical reaction comprises at least one substance selected from the group consisting of a chemical composition, an impurity content, a pH level, a temperature, a viscosity, a density, an ionic strength, a total dissolved solids measurement, a salt content measurement, a porosity, an opacity measurement, a bacteria content, and any combinations thereof.

8. The system of claim 1, further comprising an electromagnetic radiation source arranged in the optical train and emitting electromagnetic radiation, wherein the at least one detector is a first detector and the system further comprises a second detector arranged to detect the electromagnetic radiation and thereby generate a compensating signal indicative of electromagnetic radiating deviations.

9. The system of claim 8, wherein the signal processor communicably coupled to the first and second detectors, the signal processor being programmed to receive and computationally combine the output and compensating signals in order to normalize the output signal.

10. The system of claim 1, wherein the flow path comprises at least one structure selected from the group consisting of a flowline, a storage vessel, a separator, a contactor, a process vessel, and any combinations thereof.