bioluminescence reaction has been well characterized (DeLuca, M., et al., 1979 *Anal. Biochem.* 95:194-198).

Samples and Sample Acquisition Devices:

[0062] Articles and methods of the present disclosure provide for the detection of biological analytes in a sample. In some embodiments, the articles and methods provide for the detection of biological analytes from live cells in a sample. In certain embodiments, the articles and methods provide for the detection of live microbial cells in a sample. In certain preferred embodiments, the articles and methods provide for the detection of live bacterial cells in a sample.

[0063] The term "sample" as used herein, is used in its broadest sense. A sample is a composition suspected of containing a biological analyte (e.g., ATP) that is analyzed using the invention. The biological analyte may be present in a cell (e.g. a bacterium) in the sample. While often a sample is known to contain or suspected of containing a cell or a population of cells, optionally in a growth media, or a cell lysate, a sample may also be a solid surface, (e.g., a swab, membrane, filter, particle), suspected of containing an attached cell or population of cells. It is contemplated that for such a solid sample, an aqueous sample is made by contacting the solid with a liquid (e.g., an aqueous solution) which can be mixed with cell concentration agents according to the present invention.

[0064] Suitable samples include samples of solid materials (e.g., particulates, filters), semisolid materials (e.g., a gel, a liquid suspension of solids, or slurry), a liquid, or combinations thereof. Suitable samples further include surface residues comprising solids, liquids, or combinations thereof. Nonlimiting examples of surface residues include residues from environmental surfaces (e.g., floors, walls, ceilings, fomites, equipment, water, and water containers, air filters), food surfaces (e.g., vegetable, fruit, and meat surfaces), food processing surfaces (e.g., food processing equipment and cutting boards), and clinical surfaces (e.g., tissue samples, skin and mucous membranes). Samples can also include mixtures such as crude or partially-refined oil, gasoline, or paint.

[0065] The collection of sample materials, including surface residues, for the detection of biological analytes is known in the art. Various sample acquisition devices, including pipettes, spatulas, sponges, swabs and the like have been described and can be used in the methods of the present invention.

Cell Concentration Agents:

[0066] Methods of the present disclosure include the use of cell concentration agents to couple with cells that are present in a liquid sample. The cell concentration agent is contacted for a period of time with a liquid sample suspected of containing cells. The cells can be coupled to the cell concentration agent either covalently, noncovalently (e.g., by hydrophobic or ionic interactions), or by a combination of covalent and noncovalent coupling. After the cells have coupled to the cell concentration agent, the cell concentration agent can be removed from the liquid sample by, for example, sedimentation, flocculation, centrifugation, filtration or any combination of the foregoing.

[0067] "Cell concentration agent" is used broadly to include materials (e.g., particles, fibers) that can be suspended in a liquid and, thereby, capture and retain microorganisms that are present in the liquid. Although cell concentration agents can be collected by a filtration process, they do not necessarily require a filtration process to capture the microorganisms.

[0068] Certain cell concentration agents are known in the art and are suitable for use in methods of the present disclosure. Nonlimiting examples of suitable cell concentration agents include hydroxyapatite (Berry et al.; Appl. Environ. Microbiol.; 63:4069-4074; 1997), magnetic beads (Oster et al., J. Magnetism and Magnetic Mat.; 225:145-150; 2001), ferrimagnetic mineral, magnetite, chitosan, and affinity supports. The use of compositions including an immobilized-metal support material to capture or concentrate microorganisms from a sample is described in U.S. Patent Application No. 60/913,812, filed on Apr. 25, 2007, and entitled "COMPOSITIONS, METHODS, AND DEVICES FOR ISOLATING BIOLOGICAL MATERIALS", which is incorporated herein by reference in its entirety.

[0069] One exemplary type of concentration agents include diatomaceous earth and surface treated diatomaceous earth. Specific examples of such concentration agents can be found in commonly assigned U.S. Patent Application No. 60/977,200, filed Oct. 3, 2007, and entitled "MICROORGANISMS CONCENTRATION PROCESS AND AGENT"; the disclosure of which is incorporated herein by reference. When dispersed or suspended in water systems, inorganic materials exhibit surface charges that are characteristic of the material and the pH of the water system. The potential across the material-water interface is called the "zeta potential," which can be calculated from electrophoretic mobilities (that is, from the rates at which the particles of material travel between charged electrodes placed in the water system). In an embodiment, concentration agents can have zeta potentials that are at least somewhat more positive than that of untreated diatomaceous earth, and the concentration agents can be surprisingly significantly more effective than untreated diatomaceous earth in concentrating microorganisms such as bacteria, the surfaces of which generally tend to be negatively charged.

[0070] One exemplary type of concentration agent includes diatomaceous earth. Another exemplary type of concentration agent includes surface treated diatomaceous earth. Exemplary surface treatment includes a surface modifier, such as titanium dioxide, fine-nanoscale gold or platinum, or a combination thereof. Such surface treatments can be surprisingly more effective than untreated diatomaceous earth in concentrating microorganisms. The surface treatment can also further include a metal oxide selected from ferric oxide, zinc oxide, aluminum oxide, and the like, and combinations thereof. In an embodiment, ferric oxide is utilized. Although noble metals such as gold have been known to exhibit antimicrobial characteristics, the gold-containing concentration agents can be effective not only in binding the microorganisms but also in leaving them viable for purposes of detection or assay.

[0071] Useful surface modifiers include fine-nanoscale gold; fine-nanoscale platinum; fine-nanoscale gold in combination with at least one metal oxide (for example, titanium dioxide, ferric oxide, or a combination thereof); titanium dioxide; titanium dioxide in combination with at least one other (that is, other than titanium dioxide) metal oxide; and the like; and combinations thereof. In an embodiment, surface modifiers such as fine-nanoscale gold; fine-nanoscale platinum; fine-nanoscale gold in combination with at least ferric oxide or titanium dioxide; titanium dioxide; titanium