tromechanical systems (MEMS). It also has good stiffniess, allowing the formation of fairly rigid microstructures, which can be useful for dimensional stability. In a specific embodiment of the invention, the fluidic device or substrate comprises an integrated circuitry element (IC), a packaged integrated circuit, and/or an integrated circuit die. For example, the substrate may be a packaged integrated circuit that comprises a microprocessor, a network processor, or other processing device. The substrate may be constructed using, for example, a Controlled Collapse Chip Connection (or "C4") assembly technique, wherein a plurality of leads, or bond pads are internally electrically connected by an array of connection elements (e.g., solder bumps, columns).

[0119] Specific materials useful as the substrate also include, but not limited to, polystyrene, polydimethylsiloxane (PDMS), glass, chemically functionalized glass, polymer-coated glass, nitrocellulose coated glass, uncoated glass, quartz, natural hydrogel, synthetic hydrogel, plastics, metals, and ceramics. The substrate may comprise any platform or device currently used for carrying out immunoassays, DNA or protein microarray analysis. Thus, the substrate may comprise a microarray or a macroarray, a multi-well plate, a fluidic device, or a combination thereof.

[0120] In another embodiment, the fluidic device comprises circuitry that is capable of amplifying or processing the optical or electrical signals detected by the detection element. Any suitable conventional circuits may be used and integrated into the substrate for amplifying and/or processing, including filtering, the optical or electrical signals detected and collected by the detection element. The integrated circuitry may be able to generate a read-out of the optical or electrical signal independently or can be connected to an external device for generating the read-out.

[0121] In another embodiment of the invention, the sample is a liquid, a gel, a solid, a gas, or a mixture thereof. Therefore, the embodiment of the invention can accommodate samples in different physical states. In a specific embodiment, the sample is a liquid or in a liquid or solution state. In another embodiment, the sample zone comprises a reservoir, a channel, an opening, a surface, or a combination thereof. The embodiment accommodates a variety of applications in which a sample suspected of containing an analyte is to be analyzed. For example, the sample zone may be a reservoir, an opening void, or a surface that can hold a liquid sample. In such cases, the sample zone may be an open reservoir or surface, or a substantially closed void with an opening for sample input. The design of the space depends not only on the specific analysis to be done, but also on how to best situate and design the sample holding space in relation to the associated microcoil, detection element, and vibration element, as discussed herein.

[0122] According another embodiment, the sample zone for holding a sample, such as a liquid sample, may also be the whole or part of a channel fabricated on the substrate. Depending on the specific requirement, the channel may be open (a trench) or closed. The channel typically comprises an inlet and an outlet, but may also comprise other openings for fluidic communication. In another embodiment, the channel comprises two or more inlets and at least one outlet such that different reactants may be introduced into the channel from different inlets and mixed at a mixing section within the channel for specific chemical reaction. Furthermore, the channel may comprise more than two inlets and more than one mixing section such that more than one reaction may occur within different sections of the channel according predetermined manners. As discussed herein, the channel is designed in consideration with its relations with the associated microcoil, detection element, and vibration element to achieve the desired optical or electrical signal to detect the presence of the analyte.

[0123] In the embodiments of the invention, the sample zone of the device can accommodate a wide range of sample volume, including very small amount of samples. In one embodiment, the sample zone has a volume of from about 1.0 nL to about 1.0 mL. In another embodiment, the sample zone has a volume of from about 10 nL to about 10 μL. As understood by a person skilled in the art, actual sample volumes will depend on the nature of the analysis to be conducted, in addition to the design and dimensions of the device. In cases where the sample zone is a channel having two inlets and one outlet, the total sample zone may be substantially larger than the volume that is in proximity to a particular microcoil. For example, the total channel volume, excluding the inlets and outlet, may be about 1.0 μm while the volume in proximity to the microcoil may be about only 10 nL to 100 nL.

[0124] In the embodiments of the invention, many conductive materials are suitable for the microcoils. In the embodiments, the microcoil can be used for generating an excitation magnetic field across at least a portion of a fluidic zone. The selection of materials for the microcoil depends on several factors including the type and size of the coil, the desired strength of the magnetic field, the size and location of each fluidic zone, the shape, size and nature of the substrate, and the locations of the vibration element and detection element. The conductivity of the material is important to the selection. In one embodiment of the invention, the microcoil comprises copper, aluminum, gold, silver, or a mixture thereof.

[0125] In the embodiments of the invention, the microcoil is "functionally coupled" with the fluidic zones. A number of factors will be considered when functionally coupling the microcoil with the space, including the type and size of the microcoil, the sizes and locations of each fluidic zone, the desired strength of the magnetic field, and the volume within which the magnetic field will be effectuated. In a specific embodiment, the microcoil is placed near or adjacent to the fluidic zone. The specific type, size, strength, and location of the microcoil on the substrate will be determined based on the specific analysis desired by a person skilled in the art.

[0126] In one embodiment of the invention, the microcoil is a Solenoid type coil. Solenoid type microcoils are multiple spiral wire loops, which may or may not be wrapped around a metallic core. A Solenoid type microcoil, in addition to serving as a detection circuit, produces a magnetic field when an electrical current is passed through it and can create controlled magnetic fields. In the embodiment of the invention, the Solenoid type microcoil can produce a uniform magnetic field in a predetermined volume of the fluidic zone.

[0127] According to another embodiment of the invention, existing technologies can be used to construct the devices of the invention. For example, silicon process technologies can be used to construct or fabricate the fluidic device of the embodiments of the invention, such that the fluidic zones, diffusion barriers, and optionally the microcoils and vibration element can be constructed on a substrate that may also comprise an integrated circuitry component and/or microfluidic mechanisms such as flow controllers. In another embodiment, servo-mechanical components and mechanisms can be