

[0147] The sample zone or other zone of the device can also comprise a signal particle selected from the group consisting of signal affinity complexes, signal analyte complexes, and coded magnetic signal affinity complexes, among others. In certain embodiments the signal particle is a SERS-active nanoparticle, a fluorescent nanoparticle, a nanoparticle coupled to a surface-enhanced fluorescent tag, or a core nanoparticle covalently coupled to a catalytic element. In one embodiment, the signal particle is a COIN particle. In other embodiments, the signal particle is a Qdot, or another fluorescent nanoparticle, such as SEF nanoparticle or a FluoDot. In further embodiments, the signal particle is any nanoparticle (i.e. gold, silver, CdS, CdSe, copper, Eu^{3+} -coated polymer, an organic polymer (homo or hetero), an inorganic compound, or composite compounds, etc.). Additionally, the SERS-active nanoparticle and fluorescent nanoparticle can also be functionally coupled to a catalytic element. In certain embodiments, the sample zone of the fluidic device comprises the signal particle. Alternatively, the sample particle is contained within another fluidic zone. In further embodiments, different or the same signal particles can be contained within more than one fluidic zone.

[0148] Embodiments of the invention also include methods of using the devices to detect the presence of an analyte.

[0149] The device contains magnetic particles within one or more fluidic zones, and the microcoil array is activated to thereby move the magnetic particles within that zone or to another zone. In one method, the magnetic particle within the sample zone is a magnetic affinity complex. A sample suspected of comprising an analyte is introduced into the sample zone, wherein the magnetic affinity complex binds to the analyte to form a magnetic binding complex. The microcoil array is activated to move the magnetic binding complex from the sample zone to another fluidic zone.

[0150] In another embodiment, the magnetic particle is a magnetic signal affinity complex. A sample suspected of comprising an analyte is introduced into the sample zone, wherein the magnetic signal affinity complex binds to the analyte to form a magnetic signal binding complex. The microcoil array is activated to move the magnetic signal binding complex from the sample zone to another fluidic zone. It is then detected by the detection element, indicating the presence of the analyte.

[0151] In another embodiment, one or more fluidic zones also comprise a signal affinity complex. The analyte is combined with the magnetic affinity complex and the signal affinity complex, either simultaneously or sequentially, where the magnetic affinity complex and the signal affinity complex bind to the analyte to form a sandwich binding complex. The microcoil array is activated to move the sandwich binding complex to the detection zone of the fluidic network, where it is detected by the detection element, and where the detection of the sandwich binding complex indicates the presence of the analyte. In such an embodiment, the analyte is typically a protein, an antibody, or a nucleic acid.

[0152] In a further embodiment, the sample zone comprises a magnetic affinity complex, and one or more fluidic zones comprise a signal analyte complex. The magnetic affinity complex binds to the analyte in the sample to form a magnetic binding complex. Optionally, the microcoil array is activated to move the magnetic binding complex to another fluidic zone. The signal analyte complex then displaces the analyte from the magnetic binding complex to form a competitive binding complex. Optionally, the microcoil array is activated

to move the competitive binding complex to another fluidic zone. The detection element detects an optical or electrical signal from the signal analyte complex that did not form the competitive binding complex, thus indicating the presence of the analyte. In such an embodiment, the analyte is typically a small molecule such as, but not limited to, sugars, drugs, steroids, and vitamins.

[0153] In another embodiment, the sample zone comprises a coded magnetic affinity complex. A sample suspected of comprising an analyte is introduced a sample into the sample zone, wherein the coded magnetic affinity complex binds to the analyte to form a coded magnetic binding complex. The microcoil array is activated to move the coded magnetic binding complex from the sample zone to a first affinity surface where it is immobilized. Typically, the affinity agent of the first affinity surface binds to the analyte or to the affinity agent coupled to the magnetic particle. The code is detached from the bound coded magnetic binding complex. A magnetic signal affinity complex is provided in one of the fluidic zones, so situated that the detached code binds to the magnetic signal affinity complex to form a coded magnetic signal binding complex. Typically, the affinity agent of the magnetic signal affinity complex is a polynucleotide complementary to the code. The microcoil array is activated to move the coded magnetic signal binding complex to the detection zone which comprises a second affinity surface, where it is immobilized. Typically, an affinity agent of the second affinity surface comprises a polynucleotide complementary to the code. The coded magnetic signal binding complex is then detected by the detection element. The second affinity surface can comprise an array of probes for detecting any number of analytes.

[0154] The vibration element can be activated to agitate the fluid of one or more of the fluidic zones. In certain embodiments, the vibration element agitates the fluid in one or more fluidic zones to disperse the magnetic particles, analyte, and/or signal particles so that they can interact to form a binding complex. In other embodiments, the vibration element agitates the fluid in one or more fluidic zones to facilitate aggregation-disaggregation and removal of unbound signal particles and/or non-analyte components of the sample from the binding complex. For example, before the binding complex is moved to the detection zone, it is moved to the cleaning zone where the vibration element is activated to aggregate and de-aggregate the binding complex to remove unbound signal particles and/or other components from the sample from the binding complex. In other embodiments, a coded magnetic binding complex and/or a coded signal binding complex are moved to a cleaning zone by activating the microcoil array, wherein the vibration element is activated to aggregate and de-aggregate the complexes to thereby remove unbound coded magnetic affinity complex, detached code, and/or magnetic signal affinity complex before the binding complex is moved to the next zone.

[0155] Embodiments of the invention also comprise methods of fabricating the devices. One embodiment comprises fabricating a plurality of fluidic zones on a substrate, where at least one of the fluidic zones is a sample zone designed to hold a sample and a magnetic particle, fabricating one or more diffusion barriers on the substrate, wherein a diffusion barrier connects each fluidic zone to the adjacent fluidic zone; and forming an integrated circuitry component for storing data on the substrate. The diffusion barrier can be fabricated as a fluidic channel or as a thermally-sensitive barrier. In further embodiments, a microcoil array is fabricated on the substrate.