110, and bonding wires **106** and contacts (e.g., pins) **108** may be employed to facilitate electrical connections to the IC chip **102**. In one embodiment discussed further below, the field control components **400** also may include various components to facilitate wireless communication of data and control signals to and from the IC chip **102**.

[0071] **FIGS. 1 and 2** also illustrate one or more processors **600** configured to control the various components of the hybrid system **100** to facilitate manipulation of samples contained in (or flowing through) the microfluidic system **300**. The one or more processors **600** also may be configured to perform various signal processing functions to facilitate one or more of detection, imaging and identification of samples. It should be appreciated that in various configurations, the one or more processors **600** may be implemented as separate components from the hybrid system **100**, and optionally located remotely from the hybrid system, as shown in **FIG. 2** (e.g., a variety of conventional computing apparatus may be coupled to the hybrid system via one or more contacts **108**, or via wireless communications). Alternatively, some or all of the processor functionality may be implemented by elements integrated together with other components in one or more IC chips **102** that form part of the hybrid system **100**.

[0072] In the hybrid system **100**, according to one embodiment, the microfluidic system **300** may be configured as a relatively simple chamber or reservoir for holding liquids containing samples of interest. For example, as illustrated generically in **FIGS. 1 and 2**, a microfluidic reservoir having an essentially rectangular volume may include access conduits **302** and **304** to facilitate fluid flow into and out of the reservoir. Alternatively, the microfluidic system may have a more complex arrangement including multiple conduits or channels in which liquids containing samples may flow, as well as various components (e.g., valves, mixers) for directing flow. In various embodiments, the microfluidic system **300** may be fabricated on top of an IC chip **102** containing other system components, once the semiconductor fabrication processes are completed, to form the hybrid system **100**; alternatively, the microfluidic system **300** may be fabricated separately (e.g., using soft lithography techniques) and subsequently attached to one or more IC chips containing other system components to form the hybrid system **100**. Further details regarding the microfluidic system **300** are discussed below in Section V.

[0073] In other aspects of the embodiment shown in **FIG. 1**, the electric and/or magnetic field-generating components **200** of the hybrid system **100** may be disposed with respect to the microfluidic system **300** in a variety of arrangements so as to facilitate interactions between generated fields and samples contained in (or flowing through) the microfluidic system. In various implementations, the field-generating components **200** may be disposed proximate to the microfluidic system along one or more physical boundaries of the microfluidic system and arranged so as to permit field-sample interactions along one or more spatial dimensions relative to the microfluidic system.

[0074] For example, in one implementation, as illustrated in **FIG. 2**, the microfluidic system **300** may be configured as an essentially rectangular-shaped reservoir above an IC chip **102** that contains a two-dimensional array of field-generating components **200** disposed in a plane proximate to and essentially parallel to a floor of the reservoir. Such an arrangement facilitates manipulation of samples generally along two dimensions defining a plane parallel to the floor of the reservoir (indicated by x-y axes in **FIG. 2**). In another implementation, field-generating components may alternatively or additionally be disposed along one or more sides of such a reservoir to facilitate manipulation of samples along a third dimension transverse (e.g., perpendicular) to the floor of the reservoir (indicated by a z axis in **FIG. 2**). In yet another implementation, a reservoir may be "sandwiched" between two arrays of field-generating components respectively contained in IC chips disposed above and below the reservoir. In such an arrangement, the multiple arrays of field-generating components may be controlled such that three-dimensional manipulation of samples may be accomplished. Additionally, various arrangements of field-generating components with respect to the microfluidic system may facilitate rotation of samples.

[0075] It should be appreciated that the foregoing exemplary arrangements are provided primarily for purposes of illustration, and that a variety of arrangements of a microfluidic system and field-generating components (including linear or two-dimensional arrays of field-generating components, or other arrangements of discrete field generating components) are contemplated according to other embodiments to provide multi-dimensional manipulation of samples. In general, according to the various concepts discussed herein, samples of interest may be moved through the microfluidic system along virtually any path, trapped or held at a particular location, and in some cases rotated, under computer control of the electric and/or magnetic fields generated by the field-generating components **200**. In this manner, the topology of a "virtual micro-scale plumbing system" for samples of interest may be flexibly changed for a wide variety of operations based on the programmability and computer control afforded, for example, by the processor(s) **600**. This provides an extremely powerful tool for precision cell/object manipulation in both relatively simple and more sophisticated operations.

[0076] In various embodiments of the hybrid system **100** shown in **FIGS. 1 and 2**, the field-generating components **200** may be configured to generate electric fields, magnetic fields, or both. For example, in one embodiment, the field-generating components are configured and operated to produce controllable spatially and/or temporally variable magnetic fields that extend into the microfluidic system. The magnetic fields thusly generated interact with magnetic samples suspended inside the microfluidic system, examples of which include, but are not limited to, biological cells attached to magnetic beads ("bead-bound cells"). With respect to biological samples, it is noteworthy that the magnetic fields do not damage cells; rather, as discussed above, cell manipulation and identification via magnetic fields is a commonly used technique to molecularly identify a biological cell by a specific, ligand-coated magnetic bead. As discussed in further detail below, the interaction between the spatially and/or temporally variable magnetic fields and bead-bound cells or other magnetic samples enables trapping, transport, detection and imaging of single or multiple magnetic samples.

[0077] Examples of magnetic field-generating components **200** that may be included in the hybrid system **100** shown in **FIGS. 1 and 2** include, but are not limited to, a