[0147] As will be evident, the size of the particles influences a number of parameters resulting in various tradeoffs. For example, if smaller particles are used the maximum achievable array density is correspondingly greater. However, the larger surface area of a bead with a greater diameter allows the attachment of more probes per bead, resulting in a greater sensitivity and potentially a greater signal intensity for each bead and may also allow greater encoding flexibility.

[0148] The beads may comprise any appropriate magnetic material, e.g., iron (Fe), cobalt (Co), or nickel-iron alloys. As used herein, the term magnetic material includes paramagnetic materials. The beads may comprise nonmagnetic materials such as polystyrene in which magnetic subparticles (e.g., Fe_3O_4 particles) are embedded. Such particles may, for example, be dispersed throughout the nonmagnetic material or may form a core or shell below the surface of the nonmagnetic material. For biological applications, preferably at least the surface of the bead is made of a biocompatible material. Nonmagnetic biocompatible materials that may be used to coat the surface of a nonbiocompatible material such as iron include polymeric materials such as polystyrene, latex, and numerous other materials well known in the art.

[0149] In certain embodiments of the invention paramagnetic beads are used. Paramagnetic materials magnetize only when an external magnetic field is present, and thus paramagnetic beads exhibit minimal clumping. Biocompatible paramagnetic beads are available from a number of manufacturers (e.g., Dynal, Bangs Labs, Spherotech). Such beads are widely used for a variety of biological applications, and protocols for coupling biological molecules such as nucleic acids and proteins are well established. In addition, paramagnetic beads that are pre-conjugated with various binding ligands are available. For example, superparamagnetic beads manufactured by Dynal, Inc., with a 2.8 micron diameter, have been used in conjunction with a magnetic chip of the invention as described in more detail in Examples 2, 3, and 4.

[0150] Superparamagnetic beads have a proven record of more than 15 years in commercial use. Such beads are manufactured by dispersing ferrite crystals throughout a polystyrene bead during its polymerization. The crystals are ferromagnetic, but because of their nanoscale size they behave not ferromagnetically but paramanetically (the phenomenon has been termed superparamagnetism). It is believed that the orientational crystals are so small that they are randomized by thermal effects at room temperature. An array of such particles has essentially no renamence; it magnetizes substantially linearly in an applied magnetic field, losing essentially all magnetism when the external field is removed. This feature results in minimal clumping. The beads may be encapsulated for efficacy when used with enzymes (e.g., to avoid contact with iron-containing molecules) and the surface is easily modified to covalently attach biomolecules such as nucleic acids or proteins or small organic molecules.

[0151] A bead may include a detectable material such as a dye, a colorant, or a hybridization tag so that the bead may be detected on the array and identified among other beads. The detectable material can be incorporated within the bead, can be present on the surface, and/or can be linked to the bead. A particular detectable material or combination thereof can correspond to a particular probe that is attached to the bead, so that identification of the detectable material will also identify the probe. In certain embodiments of the invention a particular detectable material can correspond to a particular target, so that identification of the detectable material will also identify a target that interacts with the probe.

[0152] The range of commercially available beads (both magnetic and nonmagnetic) is vast. Beads made of many different materials and sizes are available. Beads incorporating various molecules such as fluorescent dyes, beads conjugated with various moieties or having surfaces modified to facilitate such conjugation are available. See, for example, the Microsphere Selection Guide from Bangs Laboratories, Inc., 9025 Technology Drive, Fishers, Ind. 46038-2886 at http://www.bangslabs.com/products/bangs/guide.php and additional documentation available at the Bangs Laboratories Web site (http://www.bangslabs.com).

[0153] IV. Assembling and Disassembling Arrays

[0154] A. Assembling an Array of Magnetic Particles

[0155] The magnetic particles may be introduced to the surface of the magnetic chip according to any appropriate technique. In general, it may be desirable to dispense the beads in a solution prior to introducing them to the chip. A gentle fluid flow is an appropriate means of introducing the beads to the surface of the chip. Multiple populations of beads can be combined into a single solution prior to dispensing, or individual populations of beads can be sequentially dispensed. The beads can be introduced to the chip by pouring the solution onto the chip either directly or through a device such as a tube or funnel. The beads can also be dispensed onto the chip using a syringe, pipette, etc. In those embodiments of the invention in which a microfluidic assembly is incorporated, the beads may be introduced to the surface of the chip using the channels of the assembly, possibly with the assistance of a pump.

[0156] The beads can be introduced at any appropriate concentration and in any convenient volume of fluid. The concentration may be varied depending upon, e.g., the size of the beads, the properties of the fluid in which they are dispensed, the number of attachment locations on the chip, etc. According to certain embodiments of the invention an appropriate concentration may range from approximately 50,000 to 100,000 beads/μl, from approximately 20,000 to 50,000 beads/μl, from approximately 15,000 to 20,000 beads/μl, from approximately 10,000 to 15,000 beads/ml, from approximately 5,000 to 10,000 beads/μl, etc. Higher concentrations, e.g., up to 150,000, 200,000 or even more beads/μl may be used.

[0157] The total number of beads to be introduced may be varied according, for example, to the number of attachment sites on the chip. The ratio of beads to attachment sites may influence the arraying behavior of the beads. For example, if there are many more attachments sites than beads, it is likely that most attachment sites will be empty while those that are occupied are occupied by only a single bead. On the other hand, if there are many more beads than attachment sites, most sites will be occupied by at least one bead. While not wishing to be bound by an theory, in general, the occupation of identical domains on the chip is governed by Poisson