size of the maximum dimension of a particle. Certain of the dimensions of the gap may be larger or smaller than the dimensions of the particle.

[**0092**] The effect of gap length on bead trapping is demonstrated in Example 2, which describes arraying of beads on a magnetic chip fabricated as an array of arrays, where the length of the gaps in each subarray increases from 1 to 4 μm across the chip (in a right to left direction as viewed in the fluorescence scan in **FIG. 8**. As can be seen from **FIG. 8**, too small a gap between magnetic domains results in low trapping efficiency. Too large a gap allows trapping of multiple beads at some attachment locations.

[**0093**] It will be appreciated that the magnetic islands may have pointed or partially tapered ends or flat ends as shown in **FIGS. 2 and 3**. In this case the distance between adjacent ends will depend on where in the y dimension the measurement is made. However, it will be possible to ascertain the minimum spacing between the ends, i.e., the distance in the x-dimension that separates the closest portions of two adjacent islands. As will be evident, the optimal spacing may vary depending on the size of the beads for which the chip is designed. For example, if a chip is to be used with 2.8 micron beads the spacing between ends of adjacent islands may be less than if the chip is to be used with 5 or 10 micron beads.

[**0094**] The gap width (i.e., the gap dimension in the y direction) is determined by the width of the magnetic islands, which has been discussed above.

[**0095**] (3) Distance Between Rows of Islands in the y Dimension

[**0096**] As discussed above, the length of the islands (as well as the length of the gap) influences the array density. In addition, the distance between rows of islands in the y dimension influences the array density with a smaller distance between rows resulting in a higher density of attachment sites. In certain embodiments of the invention the rows of islands are separated from each other by a distance equal to or greater than the width of the islands themselves in order to minimize interaction between localized magnetic fields produced by islands in adjacent rows.

[**0097**] (4) Magnetic Island Structure

[**0098**] As discussed above, in certain embodiments of the invention it is desirable to tailor the size, shape, and spacing of the islands to increase the likelihood of trapping one and only one bead within or adjacent to a gap region. Single bead capture is enhanced if the magnetic field in the gap is such that it permeates a single bead almost completely (i.e., such that the magnetic field lines are confined primarily to within the bead), leaving very little fringing field to bind additional beads. In the plane of the substrate, this issue may be addressed by tailoring the island and gap geometries as discussed above. In the vertical dimension, to center the field on a bead of approximately 2.8 μm diameter it would be desirable to have a magnetic island approximately 3 μm in height. However, it can be time consuming in fabrication to sputter deposit a layer of magnetic material more than about 1 μm in thickness. To address this issue, in certain embodiments of the invention a layer of nonmagnetic material, is sandwiched between the magnetic material and the substrate surface. For example, a layer of nonmagnetic material (e.g., a layer of SiO_2 approximately 1-2 μm thick for an array designed for 2.8 μm diameter beads) is deposited on the substrate using any appropriate technique, e.g., sputtering. Then a layer of magnetic material (e.g., cobalt, approximately 1 μm thick for an array designed for 2.8 μm diameter beads) is deposited on top of the nonmagnetic layer. The subsequent processing steps remain the same as described above. When etching is used, it may be desirable to select an etching method (or combination of etching methods) that will etch both the nonmagnetic and magnetic materials. The process of using a first etch for cobalt and then a second for silicon dioxide is straightforward to those skilled in the art. However, any of a number of nonmagnetic and magnetic materials could be used. The thickness of the nonmagnetic layer may be selected as appropriate for the size of bead to be arrayed, the desired height of the magnetic islands, etc.

[**0099**] It will be appreciated that the foregoing approach is not limited to application of a single layer of nonmagnetic material below the magnetic material. Any number of layers of nonmagnetic and/or magnetic material could be applied. In addition, the thickness of the layers may be such that the bead is actually suspended above the chip surface. For example, a nonmagnetic layer of approximately 2 μm thickness below the magnetic layer would likely result in a suspended bead. This may be understood as follows. The weight, or gravitational force F on the bead is given by the following equation:

$$F=mg1.4\times10^{-13}\text{ Newtons} \quad \text{(Eq. 5)}$$

[**0100**] where m=mass of bead, acceleration due to gravity 9.8 m/s^2. The mass of an M-280 Dynabead (as provided by the manufacturer) is 1.4×10^{-14} kg). Assuming that the magnetic field of the gap drops off to zero over 10 μm, the magnetic force holding up the bead is approximately 7×10^{-10} N, which is several thousand times the bead weight. (Calculation of the magnetic force on the bead is discussed below.) Having the bead suspended may offer advantages in terms of better accessibility to reagents, wash solutions, and samples (e.g., better accessibility to nucleic acid hybridization targets) than if it sits on the surface.

[**0101**] It will be appreciated that many of the above dimensions and calculations relevant to chip design will vary with the size of the magnetic particle. In general, dimensions and other features will scale according to the dimensions of the magnetic particles, e.g., the diameter of spherical magnetic beads.

[**0102**] (5) Flux Circulator

[**0103**] As described herein, fringing fields and/or magnetic fields other than the localized magnetic fields themselves may contribute to clumping of beads on the array and/or trapping of zero or of multiple beads at a given attachment location rather than trapping of a single bead. Such effects may be seen in **FIG. 13**, where clustering of multiple beads is evident at the top of the array while sites at the center of the array are more sparsely populated (i.e., a number of sites are unoccupied). While not wishing to be bound by any theory, these effects may be due to the existence of a magnetic field extending between opposite ends of the entire array or subarray, e.g., between the top and bottom of the array as seen on **FIG. 13**. This may occur because the north and south poles of each magnetic domain at the edges of the array contribute to formation of a more "global" north and south pole that extends between opposite