mately 3 μm and the width in the y dimension (i.e., the distance between the longer faces of the islands) is on the same order.

[0024] **FIG. 7** shows a schematic cross-sectional view of several islands with different vertical profiles, where the angle between the island wall at the gap and the substrate is indicated as α.

[0025] **FIG. 8** is a fluorescence image obtained (after arraying fluorescently labeled beads) from a 10×10 array of arrays, where each of the 100 subarrays contains a 30×30 pattern of magnetic islands. The inset shows an enlarged view of one of these subarrays, containing a 30×30 pattern of magnetic regions. The vertical scale in the image is 20 μm/count. Thus the inset shows a section of the chip **70** counts=1400 μm in length.

[0026] **FIG. 9** shows an image of an entire magnetic wafer patterned with an array of subarrays. The chip is approximately 3 inches in diameter and contains well over 500 subarrays at a spacing of approximately 0.1 inch in each direction. Each subarray (details not visible in image) contains a 30×30 pattern of magnetic islands such as those shown in the AFM image of **FIG. 6**.

[0027] **FIG. 10** shows process steps according to one method for fabricating a magnetic chip of the invention.

[0028] **FIG. 11** shows an AFM image of a portion of a magnetic chip fabricated according to the foregoing process. The scale is in tens of microns, showing the gap sites to be approximately 30 μm apart in both x and y dimensions.

[0029] **FIG. 12** shows a schematic view of a magnetic chip with integrated photodetectors on a substrate that forms the surface of the chip.

[0030] **FIG. 13** shows a fluorescence image obtained after performing a DNA hybridization assay on magnetic beads and then arraying the beads on a magnetic chip.

[0031] **FIG. 14** shows a schematic view of a flux circulator positioned to reduce fringing fields at the edges of an array.

[0032] **FIG. 15** shows a schematic view of an alternate chip design employing localized magnetic fields extending between opposite poles of individual magnetic regions.

DEFINITIONS

[0033] Array: As used herein, an array refers to any arrangement of elements (array elements) in physical space. In general, the elements are arranged on a substrate though this need not be the case. For example, an array of magnetic beads may be suspended in space by magnetic forces. The elements can be, for example, beads; probes; molecules; domains having different biological, chemical or physical properties (including magnetic or electric properties) to those of the substrate, etc. The elements need not be physical elements but can be, for example, locations at which attachment or immobilization (either reversible or irreversible) of such entities can occur. Thus one can speak of an array of beads, an array of probes, an array of magnetic regions, an array of gap regions, an array of sites or locations (e.g., attachment sites), an array of arrays, etc. The term "array" is also used to refer to the substrate or mechanism that provides locations for array elements. For example, a substrate on which beads are dispersed or above which they are suspended, or a substrate to which oligonucleotides are bound may be referred to as an array.

[0034] The elements in an array need not be identical, although frequently this is the case. The elements may have some similar or identical properties (e.g., they may all be magnetic beads, oligonucleotides, etc.) while they may differ in terms of other properties (for example, beads may contain different dyes for encoding purposes, may be linked to different probes, etc.) An array may have a regular pattern of elements (e.g., a grid-like arrangement consisting of mutually perpendicular rows and columns of elements), though this need not be the case. A "pattern" in this sense refers to an arrangement that has a repeating unit cell. However, the array elements in an array may also be randomly positioned. In the context of the present invention, an embodiment described below comprises an array with a regular pattern of magnetic regions and attachment sites for beads. However, the array of beads that ultimately results is random in at least two senses. First, not all attachment locations necessarily contain a bead, while some attachment locations may contain multiple beads. Second, different populations of beads may be used to form a single array, and the identity of a bead at any particular attachment location is random in the sense that it is not predictable in advance (although the relative proportion of beads from different populations may provide a statistical basis for predicting the likelihood that a bead at any given location is from a particular bead population).

[0035] An array may be characterized in terms of its density (i.e., the average number of elements present per unit area). For example, an array having a density of approximately 10,000,000 or greater elements per cm^2 may be characterized as a very high density array. An array having a density of approximately 50,000 to 10,000,000 elements per cm^2 may be characterized as a high density array. However, these terms are relative and flexible, and their meaning is likely to change over time as higher and higher density arrays become available.

[0036] Array element: An array element, also referred to as an array feature, is any entity that may be present in the form of an array. Array elements can be, for example, beads; probes; molecules; domains having different biological, chemical or physical properties (including magnetic or electric properties) to those of the substrate, etc. The elements need not be physical elements but can be, for example, locations at which attachment or immobilization (either reversible or irreversible) of such entities can occur. Thus one can speak of an array of beads, an array of probes, an array of magnetic regions, an array of gap regions, an array of sites or locations (e.g., attachment sites), an array of arrays, etc. An array element may itself contain subelements. For example, a bead array element may have multiple molecules (e.g., probes) bound to it. An oligonucleotide array may consist of an array of spots, each spot containing multiple individual oligonucleotides.

[0037] Attachment location or site: As used herein, an attachment location or site is a location in 3-dimen-