[0041] FIGS. **8**A-**8**C depict how a biopolymer (DNA) that is held by opposite ends by separated spin-valve elements can be rotated about various coordinate axes.

[0042] FIGS. **9**A-**91** depict a sequence of a magnetic particle confined by a field gradient produced by a spin-valve element during rotation of an applied auxiliary magnet field.

[0043] FIG. **10**A depicts an initial random distribution of particles before being sorted by an array of spin-valve elements.

[0044] FIG. **10**B depicts the particles of FIG. **10**A after they have been sorted.

[0045] FIG. **11**A depicts how a particle can be moved into a desired portion using a magnetic tipped probe.

[0046] FIG. **11**B depicts the magnetic tipped probe and array of spin-valve elements of FIG. **11**A in perspective.

[0047] FIG. **12** shows the force versus distance simulations for a conical and truncated tip with an 800 run diameter and a 1 μm diameter magnetic particle.

[0048] FIG. **13** shows a magnetic random access molecular manipulator according to one embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0049] The present invention provides a microfluidic platform that incorporates a platform consisting of a super array of spin-valve arrays each including arrays of individual spin-valve elements that can be used to selectively trap, manipulate and release magnetic or magnetically tagged or labeled particles with high throughput and specificity. Each array of spin-valve elements as well as each spin-valve element can exist in a ferromagnetic "ON" state in which the individual spin-valve elements act like micro bar magnets with local magnetic fields. The magnetic field gradients provide the trapping field to confine the magnetic particles. The spin-valve platforms and spin-valves can be turned to the antiferromagnetic "OFF" state where the spin-valves no longer produce a local magnetic field. In the absence of the local magnetic field, the magnetic particles are released from the spin-valve elements. The platform consists of a membrane that can separate the spin-valve arrays and spin-valve elements from the magnetic particle fluid, or it is possible to have the magnetic particle fluid on the same side of the spin-valve platforms and spin-valve elements. The "ON/OFF" magnetic characteristic of the spin-valve platforms and spin-valve elements make it possible to apply an applied global magnetic field to rotate the magnetic particles or apply torsion or tension to the magnetic particles while they are confined by the spin-valve elements. This invention may be used in a variety of applications including drug screening, nucleic acid sequencing, structural control and analysis of RNA/DNA, medical diagnosis, and magnetic particle susceptibility and size homogenization for medical applications.

[0050] The present invention provides a means by which to trap, measure, manipulate, sort and release magnetic particles with reproducible location specificity and high throughput.

[0051] The present invention further provides methods of manipulating magnetic or magnetically tagged or labeled particles by changing the alignment or strength of applied magnetic files or by the use of magnetic tweezers.

[0052] Since magnetic particles can be attached to biological molecules, these characteristics can be applied to biological systems including biopolymers or to chemical species where individual cells or molecules can be sorted, measured, rotationally and laterally manipulated, and released. It is to be understood that the term "magnetic particles" is used herein to encompass magnetically tagged and magnetically labeled biological and chemical species in reference to how the spin-valve arrays and spin-valve elements of the present invention function and are used.

[0053] The present invention consists of a microfluidic platform that includes a transparent membrane that acts as a barrier between the spin valve arrays and the fluid. The membrane can also be opaque. The membrane can be partially supported or completely supported by the substrate. The spin-valve elements can be formed on the membrane, opposite the fluid or the fluid can be on the same side as the spin-valve arrays. The array of spin-valve elements can be magnetized all at once by applying a macroscopic applied magnetic field for a duration of time or individually by applying a current pulse through a spin valve element or by applying momentary current to a set of wires in close proximity to each individual spin-valve element. The spin-valve elements then remain in a ferromagnetic "ON" state in the absence of an applied magnetic field. In this state, magnetic particles or particles that are magnetically tagged or labeled are trapped in the local magnetic field gradient of each spin-valve element indefinitely. In the "ON" state a second magnetic field of sufficient strength to rotate the particles but insufficient to change the ferromagnetic character of the spin-valve elements, can be applied to provide torsional/rotational manipulation to objects (e.g. biological specimens, chemical compounds, etc.) that can be attached to the magnetic particles. Since the spin-valve elements are arrayed as are the spin-valve arrays, the location of trapped particles can be specified by a matrix position with respect to all other spin-valve elements and spin-valve arrays in a platform.

[0054] FIG. **1** is a perspective view of a portion of micromachined magnetic trap platform (also referred to herein as a microfluidic platform) according to one embodiment of the present invention. FIG. **2** is a cross sectional view of the portion of the micromachined magnetic trap platform of FIG. **1**.

[0055] The basic micromachined magnetic trap platform includes an array of membranes each of which includes an array of magnetic traps **1**. As will be understood from the description of FIG. **3**E below, the micromachined magnetic trap platform can include a silicon wafer substrate that supports an array of suspended membrane areas which are referred to herein as, each of which includes an array of traps **1** as depicted in FIGS. **1** and **3**. The magnetic traps **1** are supported on a membrane **2** or other suitable substrate that can provide a fluid barrier as discussed below. The traps **1** comprise a layer or a plurality of layers of material that can produce a local magnetic field when an applied magnetic field is applied thereto. Examples include a soft magnetic material a (high moment low remnant field) such as Per-