To confirm the experimental force measurements, micromagnetic simulations were used to calculate the total force acting on the particles. FIG. **12** shows the force versus distance simulations for a conical and truncated tip with an 800 nm diameter and a 1 μm diameter magnetic particle. Simulations confirm that a truncated tip provides a stronger trapping force than a conical tip. For the truncated tip, the maximum lateral force acting on the particles is 45 pN. This value is slightly larger than the experimental value measured during the course of the present invention. Deviations from the experimental values obtained using hydrodynamic drag equation are most likely due to the frictional force resulting from the normal force, F_z, pulling the bead into the silicon nitride membrane surface. The force as a function of displacement from the center of the tip indicates that the size of the field gradient is comparable to the size of the particle, and the field outside the particle decreases rapidly. This localization of the magnetic trapping field allows for constant displacement measurements to be made, which is in contrast to typical magnetic tweezers that function as force clamps. While the set-up tested produced forces comparable to optical tweezers, it is possible to tailor the tip-particle geometry and magnetic material used to increase the force acting on the particle to forces typical of current magnetic tweezers apparatus ($\sim 10^2$ pN).

The magnetic material coating the side walls of the cone comprising the tip produces sufficient magnetic field gradients to attract more than one particle at a time. This is an undesirable attribute that can be resolved by implementing the traps to separate the particles. Particles less than 5 μm in diameter that are stuck together may be split up by dragging the particles over the center of a PERMALLOY™ element, where the particle furthest away from the tip will remain with the PERMALLOY™ element, while the other continues to track the field gradient of the tip.

FIG. **13** depicts a magnetic random access molecular manipulator according to one embodiment of the present invention (Note: will change description of FIG. **13** on page **8** in same manner). In FIG. **13** a micro fluidic chamber **40** that includes an array of magnetic traps **1** according to the present invention is positioned on a magnetic random access memory chip **41** that can be used to individually switch the magnetic traps **1** "ON" and "OFF" by passing current pulses through the magnetic traps or through wires **43** that are configured to address each of the magnetic traps **1**. The micro fluidic chamber **40** includes a support **44** for the magnetic traps **1** which can be a fluid permeable support such as a membrane that provides a fluid barrier between the micro fluidic chamber **40** and the underlying electronics package. The micro fluidic chamber **40** can also include a suitable structure **45** that forms a flow area **46** to contain or direct the transfer of a fluid within the micro fluidic chamber **40**. Such a structure **45** can be a silicon substrate, membrane or any suitable structure. With reference to FIG. **13** is noted that the present invention allows for the controlled movement of magnetic particles without a fluid flow channel. For example, an open surface provided with the array of magnetic traps **1** and the magnetic random access memory chip **41** of FIG. **13** (or any suitable control of the individual traps) would allow one to selectively turn "OFF" a magnet trap holding a particle and turn "ON" adjacent magnetic traps in sequence to move the particle around as desired. This eliminates the need for the type of fluid flow that is the basis of micro flow channel technology.

Although the present invention has been described with reference to particular means, materials and embodiments, from the foregoing description, one skilled in the art can easily ascertain the essential characteristics of the present invention and various changes and modifications can be made to adapt the various uses and characteristics without departing from the spirit and scope of the present invention as described above and in the attached claims.

What is claimed is:

1. A method of manipulating magnetic particles, which method comprises:

providing a fluid having a plurality of magnetic particles dispersed therein;

providing an array of spin valve magnetic traps, each of which comprises discrete substantially coplanar layers of material that, when temporarily subjected to a magnetic field of sufficient strength to change the magnetization state of the spin valve trap to an on state, produces a local magnetic field that is capable of attracting and indefinitely retaining magnetic particles proximate the spin valve magnetic traps;

bringing the fluid having the magnetic particles dispersed therein proximate the array of spin valve magnetic traps; and

temporarily subjecting each spin valve magnetic trap to the magnetic field so as to selectively switch between the on state, in which the local magnetic fields are produced and the magnetic particles are magnetically attracted and retained proximate the spin valve magnetic traps, and an off state, in which no local magnetic fields are produced and the magnetic particles are not attracted or retained proximate the spin valve magnetic traps, and wherein, in the on state, the local magnetic fields persist after the temporary magnetic field is discontinued.

2. The method of manipulating magnetic particles according to claim **1**, wherein the plurality of magnetic particles are at least one of magnetically tagged biological species, magnetically tagged cells, magnetically tagged molecules, and magnetically tagged polymers.

3. The method of manipulating magnetic particles according to claim **1**, wherein the array of spin valve magnetic traps are attached to a membrane that is supported by a substrate.

4. The method of manipulating magnetic particles according to claim **3**, wherein each of the spin valve magnetic traps comprise a multilayered spin-valve structure having two discrete magnetic layers encased in a multiple layer structure that together can selectively have either parallel or anti-parallel magnetic moments when subjected to the magnetic field to produce in total a local magnetic field that is capable of attracting and restraining and subsequently releasing magnetic particles near the spin valve magnetic traps.

5. The method of manipulating magnetic particles according to claim **3**, wherein the membrane is transparent.

6. The method of claim **3**, wherein the membrane is at least partially free-standing so as to define opposite surfaces, wherein the plurality of spin valve magnetic traps are attached to one of the opposite surfaces of the membrane, and wherein the fluid having the magnetic particles dispersed therein is brought proximate the array of spin valve magnetic traps on the other of the opposite surfaces of the membrane so that the membrane provides a barrier between the fluid and the plurality of spin valve magnetic traps.

7. The method of manipulating magnetic particles according to claim **6**, wherein the membrane is transparent.

8. The method of manipulating magnetic particles according to claim **1**, wherein the coplanar layers of material that produce the local magnetic field comprises a high moment low remnant field material.