NANO HIGHLIGHT
Microfluidic Device for Manipulation of Micro/Nano Particles and Droplets

NSF NIRT Grant 01023455

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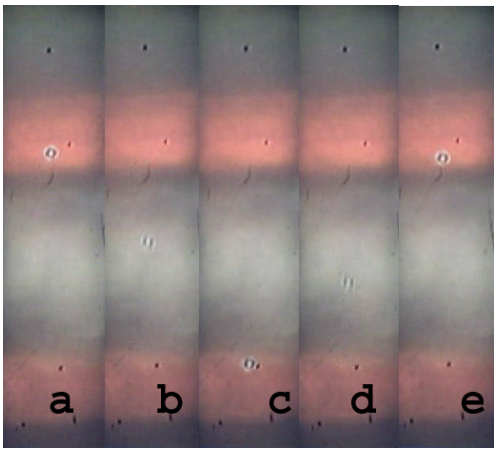
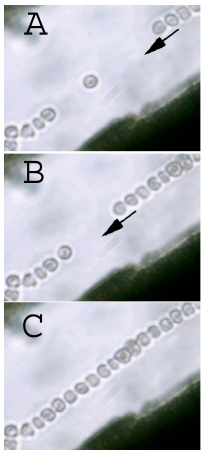
We have designed[1] and fabricated[2,3] Magnetic Microlevitation Chip's (MMC) which use the magnetic field from micron scale permanent magnets to levitate/trap diamagnetic droplets and particles with sizes in the 50 nanometers – 50 microns range. By using DC/AC electric and magnetic fields the chip can manipulate the levitating/trapped droplets/particles: move them on chip (see Fig.), store (no time limit), rotate, merge, assemble (see Fig.), etc. The manipulated objects include (but are not limited to) polystyrene microspheres[2] as small as 50nm in size, micron size droplets of water, alcohol, glycerin and oils, microparticles of bismuth and antimony, multiwalled nanotube powder, cells in a buffer solution[3] (see Fig) and in droplets. The chip can be used as an appendage to optical microscopes. It can apply controlled forces on droplets /particles with ***attonewton*** accuracy and manipulate droplets with volumes in the ***picoliter*** - ***femtoliter*** range, which is a ***billion times smaller*** than the recently reported[4] droplet size for on-chip manipulation of droplets in a buffer solution. Control of femtoliter size droplets provides the possibility to control chemical reactions between single molecules (one molecule per droplet corresponds to a nanomole concentration). MMC is easy to operate, inexpensive, can be combined with other devices, e.g. optical tweezers. MMC parameters can be improved by several orders of magnitude and a low temperature, high vacuum version is feasible. MMC has enormous potential for applications in chemistry, biochemistry, biology, pharmaceutical and micro/nanofluidics[4].





Time sequenced photographs of: Left-–6 micron diameter droplet (about 100 femtoliter volume) levitated in air 60 microns above the chip surface. It is moved by the magnetic field from the electrodes (red) back and forth between potential energy minima (top view). Right- Assembling a chain of red blood cells in a magnetic trap inside a buffer solution (top view).

References

[1] I. Lyuksyutov, J. Mod. Phys. Lett. B **16**, 569 (2002).
[2] I. Lyuksyutov et al J. Mod. Phys. Lett. B **17**, 935 (2003)
[3] I. Lyuksyutov and D. G. Naugle, Invention Disclousure, TAMU.
[4] O. D. Velev, B. G. Prevo, K. H. Bhatt, Nature, **426**, 515 (2003).
[5] For further information about this project email **lyuksyutov@physics.tamu.edu**