

Magnetic Arrays and Transport of Bio-Functionalized Particles

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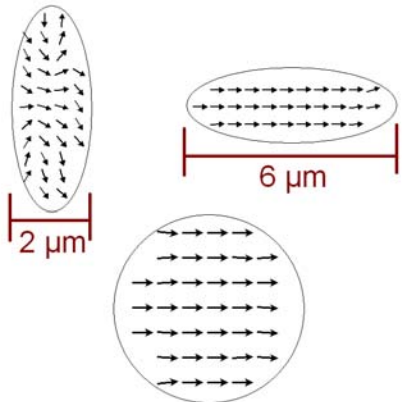
Purpose

Investigate techniques for transporting magnetic micro-particles with high temporal and spatial resolution for biological research applications.

Approach

Design of Magnetic Structures:

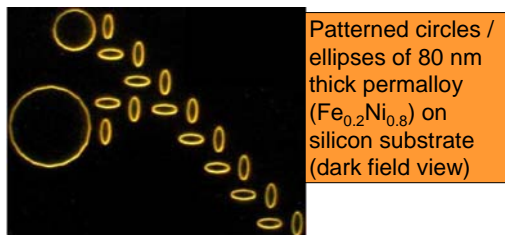
- Patterns/shapes of thin (~50 nm) modules of soft magnetic metals.
- Design based on numerical simulation



Magnetic profiles of circular and elliptical disks under applied field of 8 mT

Fabrication:

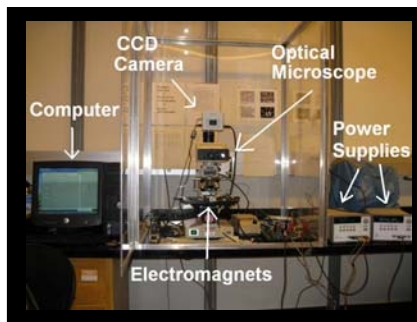
- Electron beam to pattern desired shapes
- Sputter deposition to grow thin metal films on designed contours



Patterned circles / ellipses of 80 nm thick permalloy ($\text{Fe}_{0.2}\text{Ni}_{0.8}$) on silicon substrate (dark field view)

Magnetic Particle Transport:

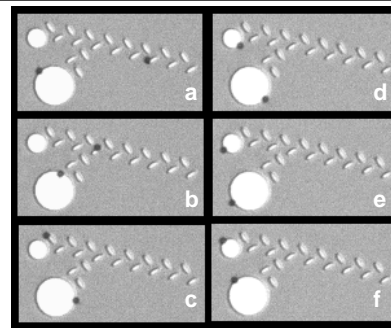
- Magnetic field applied to induce magnetization of patterned structures.
- Local field gradients attract magnetic particles (2.8 μm diameter) - much like paper clips to a bar magnet.
- Developed computer program to control and manipulate fields to transport particles.



- Transportation/movement of particles achieved by manipulating magnetic field

Observations and Analysis:

- Capture and movement of magnetized particles observed and recorded using optical microscope.



Magnetic particles moving on patterned structures (bright field view)

Results

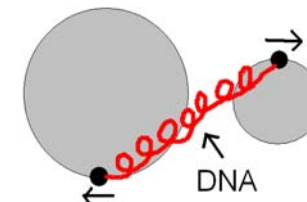
- The particles were transported using patterned elliptical shapes oriented perpendicular to one another in rotating magnetic field.
- Particle movements around perimeters of circular and elliptical shapes observed.
- Able to control of pathway and speed of particles on surface.
- Capability to tune separation between two particles using circular disks of different diameters

Applications

- Planar platform for assembling biological molecules in desired landscape.
- Stretching DNA by attaching a particle to each end
- Examine forces between cells and antibodies.

Next Steps

- Moving cells, viruses and DNA attached to magnetized particles
- Develop technique allowing forward and reverse transportation of biological molecules.
- Stretching DNA strand
- Extend technique to separate particles with cells attached from those without cells



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References

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