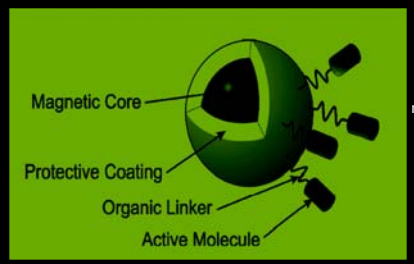
DRUG DELIVERY USING MAGNETIC NANOPARTICLES

Jennene Fields, Julie Chang, Seyoung An, Joshua Sautner, Vitali Metlushko
University of Illinois @Chicago, Electrical Engineering

Introduction

One of the main issues with drug delivery is that drugs tend to disperse throughout the entire body, instead of targeting the specific site (or area) that it is intended to reach. Therefore, drugs are currently delivered based on the premise of giving a larger dose than needed and hoping that the correct dosage reaches the target site. This can and does lead to adverse side affects. It is with this detriment in mind that we have actively searched for alternative methods. One of the most interesting and promising candidates for more focused drug delivery systems is magnetic manipulation of nanoparticles. For such a system, it is necessary to create structures that have well defined magnetic properties and a strong localized magnetic field. We propose to confine and control the location and movement of an individual magnetic nanoparticle in liquid environment by controlling the position of magnetic domain walls. We have demonstrated that our structures are capable of capturing and moving a single magnetic nanoparticle.

Magnetic Nanoparticles

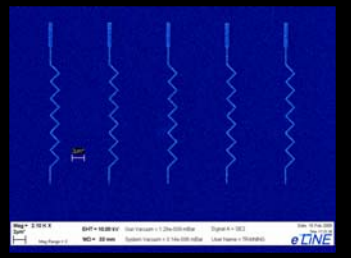


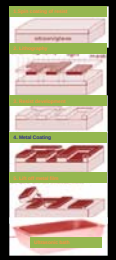
Defining the Magnetic Nanoparticle

The consist of a metal or metal-oxide core, encapsulated in an inorganic or a polymeric coating that renders the particles biocompatible, stable and may serve as a support for biomolecules.

Advantages.
- Can be visualized in the body (used in MRIs)
- Can be guided to a target location
- Can be held in a location
- Allows for controlled release (alternate magnetic field-heat)

Fabrication of Magnetic Structures



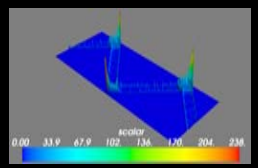


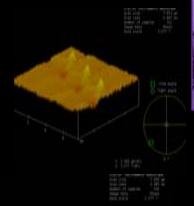
-E-Beam Lithography

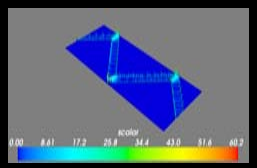
-Scanning Electron Microscopy (SEM)

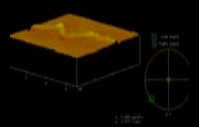
- Metal Deposition

Simulation and Characterization







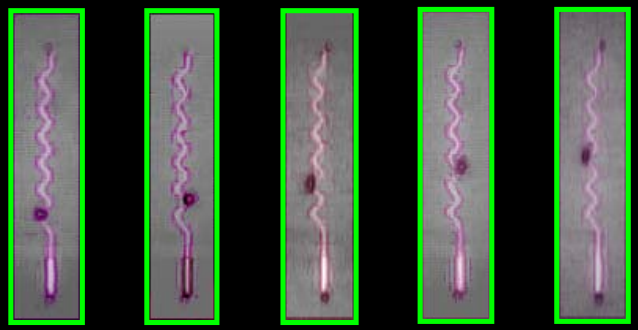


Magnetic Force Microscopy (MFM)

OOMMF (Object Oriented Micro Magnetic Framework)

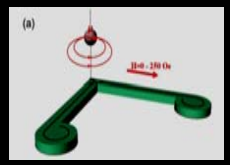
Control of the Domain Walls

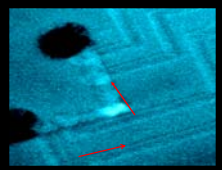
Control over domain wall propagation allows for control over particle movement.



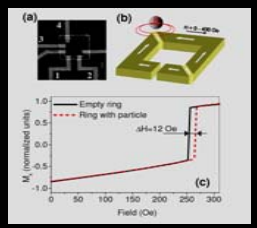
Release Mechanism

Several ways to release the particle can be used. It will be necessary to optimize which one will be the most effective.





Sensor



By adding leads onto the device, the device gains the capability to sense the presence of a bead. The device experiences a magnetoresistnce, changing the field strength required to move the domain wall

Conclusion

- Magnetic Nanoparticles offer several advantages over other drug delivery methods
- Advanced fabrication and characterization is required to create the magnetic nanostructures
- We are able to control magnetic particle movement with nanometer resolution.
- Several Catch and Release mechanisms are being considered.
- This system can dual as a sensor by detecting magnetoresistance.

Our group created a vehicle that can drive particles to a location 1 by 1 with nanometer precision!!

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