Fluorescent Magnetic Nanoparticles for Cell Manipulation and Imaging

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Imaging

Drug Delivery

Biomimetics
Properties of Nanoscale Materials

- **Quantum Dots**
  - Broad Excitation
  - Narrow Emission Bandwidths
  - Low photobleaching
  - High Quantum Yield

- **Magnetic Nanoparticles**
  - Reduce T2 relaxation (MRI)
  - Biocompatible
  - Biodegradable
  - Exert force in magnetic field

- **Gold Nanoparticles**
  - Surface plasmon resonance
  - Sizes from 2-100 nm
Magnetic Quantum Dots

Xu’s Group

Gu et al., JACS, 2004, 5664

Farle’s Group

Ying’s Group
Micelle-Encapsulated Particles


DSPE-PEG2000
Dye-FeOx-Micelles

Est. 5 dye/particle

FeOx-FITC-Micelles

State of the Art Tumor Resection
Collaboration with Dr. Atom Sarkar, Neurosurgery

Figures courtesy Dr. Atom Sarker, OSU Neurosurgery

NO DIRECT TUMOR VISUALIZATION DURING SURGERY!
How can we visualize brain *in situ*?

Multimodal Nanoparticle
- Fluorescent
- Magnetic

Figures courtesy Dr. Atom Sarker, OSU Neurosurgery

Figure adapted from http://www.nlm.nih.gov/medlineplus/ency/imagepages/8736.htm
**In Vitro Cell Labeling**

- **Micelle QD PL**

  - Wavelength (nm)
  - Photon counts (AU)
  - $\lambda_{\text{excitation}} = 577$ nm

- **T Cells with labeled with targeted micelles**

- **GBM Cells with untargeted micelles**
Non-Toxic Fluorescent Particles

Synthesis Procedure

Collect Soot

Reflex

Ar

water

Nitric Acid

Cleaning & Filtration

Centrifuge

CNP TEM

www.freefoto.com
Fluorescence of CNPs

- **CNP Excitation**
  - Core defects
  - Surface sp² clusters
  - Core (N−V)⁻ centres

- **CNP Absorbance and PL**
  - CNP Excitation
  - CNP Absorbance and PL
In vitro Labeling with CNPs

GBM Cells Labeled with bare CNPs

GBM Cells Labeled with PLGA-CNPs
What if we could mechanically “wire-up” neurons?

Collaboration with Dr. R. Sooryakumar, Physics and Dr. Jeff Chalmers, Ch Eng

Magnetic Wound Healing

• Tissue Regeneration
• Developmental Biology
• Neural Computing

4.5 μm magnetic bead (β1 integrin)

The Nerve Growth Cone

http://www.blackwellpublishing.com/11thhour/matt/about/u1ch2b.html

http://thebrain.mcgill.ca/flash/a/a_09/a_09_m/a_09_m_dev/a_09_m_dev.html
Nanoparticles for Cell Manipulation

Micelles

Magnetic Manipulation

Particles Attracted by Gradient

Magnetic Field

Microinjection

Endocytosis
Magnetic Manipulation

Rotation Around Magnetic Disks

Trapping and Motion Along Magnetic NWs
The Winter Group

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Nanoparticles Synthesized by Winter Group

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