Lester Wolfe Workshop in Laser Biomedicine

Nanoparticles in Biomedicine: Let There be Light!

Tuesday, November 15, 2005
4:00-6:00 PM
Grier Room, 34-401
EG&G Education Center, MIT
50 Vassar Street, Cambridge

Refreshments served at 3:30 pm

In recent years there has been an explosion in research on biomedical applications of nanoparticles. This workshop will explore the role of optics and photonics in this interdisciplinary field. Topics include gold nanoparticles for cancer diagnosis and therapy, fluorescent quantum dots for imaging disease, and novel approaches to drug delivery and tissue engineering

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All That Glitters is Gold: Potential *in vitro* and *in vivo* Biomedical Applications of Noble Metal Nanoparticles

Ivan El-Sayed, University of California at San Francisco

Properties of Semiconductor Quantum Dots Relevant to Imaging

Moungi Bawendi, MIT

High Throughput Approaches to Drug Delivery and Tissue Engineering

Daniel Anderson, MIT

Sponsored by the GR Harrison Spectroscopy Laboratory, MIT, MGH Wellman Center for Photomedicine, the Harvard-MIT Division of Health Sciences and Technology, and the Center for the Integration of Medicine and Innovative Technology (CIMIT)

SUMMARY 11/15/2005

The meeting was held in conjunction with the Lester Wolfe Workshop in Laser Biomedicine and was devoted to the topic of Nanoparticles in Biomedicine, with an emphasis on the role of optics and photonics.

Ivan El-Sayed, MD, UCSD School of Medicine, presented on: “All That Glitters is Gold: Potential in vitro and in vivo Biomedical Applications of Noble Metal Nanoparticles”. An interesting optical property of gold nanoparticles is that their optical absorption and scattering peaks can be tuned by varying their size (20 nm range) and shape; in particular these peaks can be put in the near-infrared optical window (800-1300 nm). Gold nanoparticles are thought to be biocompatible and can be conjugated to a variety of moieties, making them promising probes for in vivo and in vitro applications. Preliminary reports have demonstrated their potential as single color contrast agents for several techniques such as confocal microscopy, confocal endoscopy, and atomic force microscopy. In tissue and cell studies the addition of gold nanoparticles to collagen has been shown to reduce the fluorescence, an effect attributed to the catalytic effect of the particles on the NADH to NAD conversion. Conjugation to anti-EGFR antibodies shifts the absorption and scattering peak because of the sensitivity of the particles to the environment. These conjugated nanoparticles have been shown to have use as targets for photothermal killing of cancer cells by laser light.

Moungi Bawendi, PhD, MIT discussed “ Properties of Semiconductor Quantum Dots Relevant to Imaging”, presenting an overview of the chemistry and photophysics of semiconductor nanocrystals (quantum dots) relevant to their application in biomedical imaging. The study of quantum dots has a 20-25 year research and development history, partially due to the materials science issues involved in producing reproducible material. Today the dots consist of an active core of a II-VI semiconductor such as CdSe, an inorganic shell and an outer organic passivating layer. Typical sizes are in the 1-15 nm range. Fabrication techniques started using batch-mode techniques in liquid phase, moving to flow systems using microcapillaries, which have mixing problems, and are now moving to a gas-liquid system. Dots are now commercially available for use as molecular probes. Initial biomedical demonstrations include the imaging of blood flow in the mouse brain and studies of sentinal node localization using near-infrared emitting dots. The hydrodynamic diameter of existing dots may be too large for transport into tumors but works well for the sentinal node application. A new generation of smaller dots is under development; size reduction will involve reducing the thickness of the polymer shells, needed to avoid binding to serum, which are around the semiconductor core. Dots coated with a dye molecule have been made to make a two-wavelength fluorescent moiety which can sense pH using the relative strength of these wavelengths.

Daniel Anderson, PhD, Chemical Engineering, MIT described some “High-throughput Approaches to Drug Delivery and Tissue Engineering”. The combinatorial, automated high-throughput synthesis and evaluation of small molecules has revolutionized modern drug discovery. Dr. Anderson's lab has developed platforms that enable the rapid synthesis and testing of large libraries of synthetic biomaterials for delivery of genes, RNA, and drugs, as well as for characterization of cell interactions. These methods have been used to identify degradable polymers with excellent in vivo delivery properties as well as materials that offer new levels of control over stem cell behavior. A potential clinical target is benign prostatic hyperplasia using a polymer, identified by screening, to deliver DNA to the prostate.