Magnetic Interfaces and Nanostructures
Room 204 - Session MI+BI-FrM

Biosensors and Biomagnetism
Moderator: D.P. Pappas, NIST-Boulder

9:00am **MI+BI-FrM3 Engineered Magnetotactic Bioreporter Bacteria@footnote 1@**, ***L.J. Whitman**,* Naval Research Laboratory **INVITED**
There is an urgent need for compact, low power, broad spectrum sensors for sentinel point detection of toxins and pathogens. Although cell-based sensors have the potential to meet many of these requirements, it is a challenge to make such systems deployable because of the fragility of most cell cultures and the short lifetime of most bioreporter cells. We are addressing these issues by developing a robust, microbial sensor based on a strain of magnetotactic bacteria, Magnetospirillum magneticum AMB-1, that naturally produces an intracellular chain of magnetite nanoparticles (magnetosomes). We have produced a variety of genetically engineered AMB-1, including magnetic knockouts, with the goal of creating a reporter strain that only produces magnetosomes in the presence of specific toxic industrial chemicals. Wild-type and engineered strains have been extensively characterized by a variety of physical and chemical methods. We have determined that magnetosome production can be a rapid process, occurring in minutes, and that iron uptake correlates well with the measured magnetic moments. To rapidly determine when magnetosomes are present in the live cultures, a miniature optical system has been developed that detects differential light scattering from magnetically-aligned bacteria. Because stable populations of AMB-1 can be maintained for weeks under a range of environmental conditions, this organism appears to be a promising candidate for cell-based sentinel point detection. @FootnoteText@ @footnote 1@This work was done in close collaboration with M. B. Johnson, A. Krichevsky, J. C. Rife, M. J. Smith, C. R. Tamanaha, and R. J. Tonnuci at NRL, and B. M. Applegate, L. N. Csonka, L. K. O'Connor, and L. Perry at Purdue University. Supported by DARPA BioMagnetICs.

9:40am **MI+BI-FrM5 Synthesis and Surface Engineering of Superparamagnetic Nanoparticles**, ***R. De Palma**, S. Peeters, K. Bonroy, G. Reekmans, F. Frederix, W. Laureyn, G. Borghs, C. Van Hoof,* IMEC vzw, Belgium; *G. Maes,* KULeuven, Belgium
Superparamagnetic nanoparticles with appropriate surface chemistry have been widely used for numerous applications such as MRI, hyperthermia treatment, magnetic biosensing, etc. These applications require that the nanoparticles have high magnetization values, a well-defined and controllable morphology and an overall uniform size distribution. In addition, these applications need special (bio)chemical functionalisation of the magnetic nanoparticles, specifically tuned towards their demands. Most work has been done in improving the quality of magnetic nanoparticles, but only a few scientific investigations have been carried out in engineering and improving their (bio)chemical surface characteristics. Here we present several approaches, to engineer the surface characteristics of superparamagnetic nanoparticles, without altering their magnetic and morphological characteristics. Monodisperse superparamagnetic nanoparticles with controllable size, shape and magnetic properties were synthesized based on the thermal decomposition method. The chemical functionality of these nanoparticles could be tuned by the covalent attachment of thin silane SAMs on the particle surface. An optimized procedure allowed the controllable deposition of high quality silane SAMs with different endgroups. By these means, the nanoparticles could be made water-soluble and capable to covalently couple biological receptors. Several receptors were successfully immobilized onto magnetic nanoparticles, while retaining their biological activity. The degree of receptor immobilization was determined to be 2-10 times higher, compared to 2D substrates. The synthesized magnetic nanoparticles were also coated with a thin shell of inorganic material such as Au and SiO@sub 2@ based on a novel and straightforward coating procedure. The superparamagnetic nanoparticles were characterised using TEM, XRD, FTIR, XPS, UV/vis, SQUID and Bradford.

10:20am **MI+BI-FrM7 Shaken Not Stirred, A New Approach to Biomagnetic Sensing**, ***A. Hoffmann**, S.-H. Chung, K. Guslienko, S.D. Bader, C. Liu, B.D. Kay, L. Makowski, L. Chen,* Argonne National Laboratory **INVITED**
Micron and nanosized magnetic particles coated with biochemical surfactants have emerged recently as an important component for enabling many biological and medical applications. Among these biomagnetic sensors have received a lot of attention lately, due to their potential advantages of simplicity and rapidity. The most common approach to biomagnetic sensors utilizes magnetic beads, whose magnetic moment is detected by a magnetic field sensor, such as a giant magnetoresistive spin valve. In contrast we demonstrated a new substrate-free approach to biomagnetic sensing which uses the magnetic ac-susceptibility of ferromagnetic nanoparticles suspended in a liquid for the signal transduction.@footnote 1@ The magnetic relaxation of these nanoparticles is due to their Brownian rotational diffusion, which is easily modified by binding the target of interest to the particles. This scheme has several distinct advantages; (i) it requires only one binding event for successful sensing; (ii) since there is a useful signal both in the absence and presence of the target it has an inherent check for integrity; and (iii) the signal contains information about the size of the target besides the biochemical affinity, which may be used to further distinguish between several different potential targets. We are developing novel magnetic viruses for application in our sensing scheme. They provide a well-defined, mono-dispersed size distribution of the ferromagnetic particles and offer the possibility to readily engineer the desired biological recognition functionality. This work was supported by DOE, BES under contract W-31-109-ENG-38 and DARPA under contract 8C67400. @FootnoteText@ @footnote 1@ S.-H. Chung, et al., Appl. Phys. Lett. vol. 85, 2971 (2004).

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