Yale Institute for Nanoscience and Quantum Engineering

Friday, February 3, 2012

12:00 to 1:00 p.m.

MASON LAB
9 Hillhouse Avenue, ML211
Light lunch will be served at 11:45 a.m.

Professor Paul R. Van Tassel
Department of Chemical and Environmental Engineering, Yale University

" Polyelectrolyte nanofilm biomaterials: optimizing mechanical rigidity and bioactivity"

Nanofilm biomaterials – formed by the layer-by-layer assembly of biocompatible polyelectrolytes – are important systems for a variety of cell-contacting applications. Mechanical rigidity and bioactivity are two key film properties known to significantly influence the behavior of contacting cells. Cells tend to attach more efficiently to "harder" films, and bioactivity may be conferred through the incorporation of proteins, peptides, or drugs within the film architecture. A key challenge is to realize films that are simultaneously rigid and bioactive. Chemical cross-linking of the polymer framework – the standard means of increasing a film's rigidity – often enhances cell attachment, but can suppress bioactivity. In particular, cross-linking steps can deactivate embedded biomolecules, limit their mobility, and/or suppress film biodegradation, thus limiting the extent of cell-bioactive species interaction. We present here two strategies to decouple mechanical rigidity and bioactivity, potentially enabling nanofilm biomaterials that are both mechanically rigid <u>and</u> bioactive. One approach is to selectively cross-link the film's outer "skin", to promote cell attachment, such that the film interior remains "soft", to promote cellular interaction with bioactive species. The other approach involves nanoparticle templates, whose removal following full-film cross-linking yields pore space capable of significant bioactive species loading. We characterize film assembly and cross-linking extent via quartz crystal microgravimetry with dissipation (QCMD) and Fourier transform infrared spectroscopy in attenuated total reflection mode (FTIR-ATR), film rigidity via nanoindentation analysis, and cell adhesiveness with respect to a system of pre-osteoblastic MC3T3-E1 cells. We show both strategies to yield films whose mechanical rigidity and cell adhesiveness are comparable to standard cross-linked (positive control) films, but whose bioactive species loading capacity is significantly enhanced. Nanofilm biomaterials that are simultaneously cell adhesive and bioactive are excellent candidates for a variety of cell contacting applications.

Professor Michel Devoret
Department of Applied Physics, Yale University

" Quantum Measurement in Action"

We have recently engineered a microwave amplifier capable of detecting signals with energies as low as that of only one photon at 8GHz, a quantum 100,000 smaller than a visible photon. Using this amplifier to monitor in real time the computational state of a superconducting quantum bit, we have experimentally verified one striking prediction of quantum theory: although the continuous measurement of one dynamical variable of a system perturbs its state unpredictably, the measurement record itself always contains enough information to keep track of the system perfectly.