CIMIT MEETING SUMMARY 07/13/2004

Joerg Lahann, PhD, University of Michigan, presented a tutorial lecture on "Engineering Designer Surfaces". Among the critical aspects of surface engineering are the design of biologically-relevant structures, which may allow the formation of drug gradients along their surfaces, and which consist of 3-D microstructures. The techniques involved in fabricating biologically-relevant structures are often different from those used in semiconductor microfabrication. The latter typically involve hard materials, such as silicon and metals, which are patterned by dry photolithographic processes. Fabrication of biologically-relevant surfaces usually involves soft materials, such as polymers, wet patterning processes and, frequently, activation by molecular recognition. A "smart surface" that can reversibly switch properties in response to an external stimulus was described as a proof-of-principle example. A single layer of molecules is deposited and aligned at a surface using self assembly; the molecules can be flipped between two defined microscopic states, which result in either a hydrophobic or hydrophilic surface, by the application of a weak electric field. Careful design is necessary to obtain a surface in which the molecules can move (bend) without interfering with each other. A novel class of polymers that is useful for biomimetic and spatially-directed surface engineering was described. The underlying coating technology uses chemical vapor deposition (CVD) polymerization to deposit a wide range of polymers on various substrate materials. Deposition can occur below room temperature and reactive coatings compatible with soft lithographic processes can be deposited, allowing for patterning of proteins, DNA, cytokines, and mammalian cells.

Jinming Gao, PhD, Case Western Reserve University, presented a tutorial lecture on "Amphiphilic Polymer Micelles for Cancer-Targeted Drug Delivery". Drug delivery for cancer faces some ongoing problems. Drugs frequently have a low solubility in water, their uptake is nonspecific, resulting in systemic toxicity, and clearance is often more rapid than desired. Traditionally, small organic molecular surfactants have been used to solubilize hydrophobic drugs, but fast dissociation and lack of stability limits their usefulness. More recently, amphiphilic polymers have emerged as a superior class of materials for drug delivery. These polymers self-assemble into nanoscale micellular structures (10-200 nm in diameter) with a distinctive hydrophobic core for drug encapsulation and a hydrophilic shell for particle stabilization. These polymers are relatively stable in blood and have demonstrated increased solubility for cancer drugs, such as paclitaxel. Micelles whose core has been loaded with SPIO (superparamagnetic iron oxides) have application as contrast agents for MRI; targeting agents can be attached for selective delivery. Micelle efficacy is being improved by studies of uptake by cells as a function of composition. Non-specific uptake by the reticuloendothelial systems (RES) has been reduced or eliminated and controlled release in time can be achieved.