

# RESEARCH CLUSTER B:

## Polymers in the BioArena

**Faculty Participants:** Maria Santore and Gregory Tew (cluster co-leaders) and Al Crosby

The interface between biological systems and synthetic materials is of imminent importance to modern science and medicine. It forms the basis for numerous medical advances, disease treatments, diagnostics and sensors, delivery systems, and implants. Indeed, a historical association between polymer science and biology derives from the polymeric nature of many naturally occurring biomolecules. Cluster B's mission is to develop fundamental insight into the complexities of these interactions thus facilitating the discovery of novel technologies, smart materials, and innovative treatments for disease.

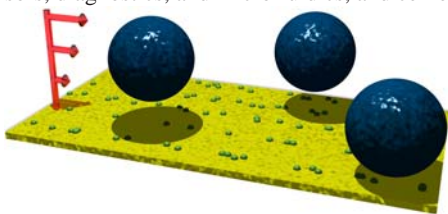
Materials interact chemically with biomolecules while cell-material contact is governed by both biochemical and mechanical signals. Research within the cluster explores and exploits molecular-, cell-, and tissue- level interactions on surfaces and in bulk biomaterials.

### BioInert Surfaces:

The body's response to artificial surfaces controls the effectiveness of implants and other medical devices including materials that contact fluids outside the body, such as those used in aphoresis and dialysis. The first interactions involve the adsorption of dissolved proteins, determining the ultimate fate of the biomaterial. Center research focuses on the synthesis of new bioinert surfaces or coatings as well as novel applications of established biocompatible molecules. Capabilities include high precision quantification of protein adsorption in real time.

### Surfaces for Controlled Cell Interactions:

Biomimetic surfaces are being developed with artificial receptors to interact with cells and tissues in a variety of situations. Newly synthesized macromolecules for implant coatings direct specific interactions with neighboring tissue. Also, novel bio-active surfaces are being developed to selectively capture flowing bacteria or mammalian cells through specific interactions, allowing for their further manipulation. This represents a coupling of chemical, mechanical, and hydrodynamic stresses, with the outcome being the targeted dynamic cell response. Cells are subject to stresses from shear fields, and from adhesion to the material. Cells may be made to roll for purposes of separation or transfer of molecules to the cell surface, they may be exposed to surface-immobilized biochemical signals, they can be grown to confluence, and later individual cells or tissues may be released. Material surfaces in this thrust area have applications in implants, catheters, sensors, diagnostics, and microfluidics, and cell engineering.



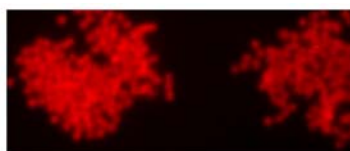
Selective surface designed for bacterial manipulation / cell sorting

**Polymers with Protein-like Bioactivity:** The ability of synthetic macromolecules to perform protein-like functions remains an important challenge. Work within the cluster has demonstrated the ability to effectively capture the antimicrobial activity of natural proteins which are a main component of the innate immune system. It represents an important 'proof of concept' principle that there is no inherent impossibility to designing novel polymers with protein-like biochemical properties.

control



antimicrobial

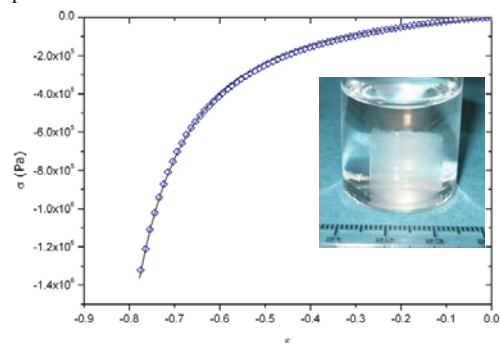


Staph. Aureus (green) in the control are alive; when exposed to our antimicrobial polymers they aggregate, (red), and are killed.

This antimicrobial technology has been translated into coatings based on a wide variety of polymers spanning medical materials to polyolefins. They are broadly active and kill bacteria in 2 minutes upon contact.

**Targeted Drug Delivery, and Regenerative Medicine:** Targeted drug delivery and organ regeneration represent two important contemporary themes at the interface of polymer and biological sciences. The synthesis of novel macromolecules and the design of new soft material elements (from vesicles to implantable scaffolds) that achieve specified performance are of critical importance. Integration of design elements from the molecular to mesoscopic are incorporated into new materials with focus on 3-D structure and surface control. The combined expertise within the center allows a much deeper understanding into structure-property relationships of the biomaterial-cellular interface.

**Coupling Novel Chemistries to Mechanical Response:** An important, yet unexplored, area in soft materials is learning to couple novel chemistries and mechanical properties to cellular response. This is a newer effort within the Cluster and represents an expansion of the research expertise.



Compression response of a novel degradable hydrogel.

### Additional Areas of Expertise

- Biomaterial Surfaces and Coatings
- Drug Delivery Carriers
- Biomimetic Membranes and scavengers
- Material-Directed Cell Signaling
- Biologically-Active Polymers
- Cell Separation: In Vitro and Ex-vivo
- Nanofiltration
- Biosensors
- Antifouling and Superabsorbent Materials
- Soft Material Mechanics
- Cell Signaling and Stem Cell Manipulation
- Gene Delivery-Cell Penetrating Peptide Mimics

### Contact Information

To participate in a CUMIRP Part I research cluster please contact the Center for UMass / Industry Research on Polymers:

**James D. Capistran, Director**  
University of Massachusetts Amherst  
Silvio O. Conte Center for Polymer Research  
Amherst, MA 01003-4530  
Telephone: 413-545-2236  
Fax: 413-577-1517  
Email: cumirp@polysci.umass.edu