Home
About Us
Research
Prospective Students
Current Students
Faculty & Staff
Calendar
Employment
McCormick Home

Study Abroad
MS in Biomedical & Environmental Engineering

Core Faculty Profile

Phillip B. Messersmith

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Research Interests

My group seeks to develop unique biomaterials for the repair, replacement, or augmentation of human tissue. Current research is focused in three main areas:

Biomimetic/Bioinspired Materials

The use of biological strategies to synthesize and/or process materials (biomimetics) is a rapidly emerging area of material science and biomaterials research. A large research effort is underway to develop novel adhesive biomaterials. Specifically, we are developing synthetic polymers that mimic the composition and properties of adhesive proteins found in nature. In one project single molecule biophysical studies are being performed to understand the role of specific amino acids on biological adhesion. Of particular interest are adhesive amino acid residues that are found in protein 'glues' secreted by marine mussels. The information gained from fundamental molecular adhesion studies is incorporated into biocompatible polymers for potential use as adhesive biomaterials. In another project, features of mussel and gecko adhesion are combined in a unique way to make a temporary adhesive useful in both wet and dry environments. Other projects involve the design of rapid in-situ formation of peptide, protein, and polymeric hydrogels. Such materials may be useful for tissue repair and for injectable regenerative medicine strategies.

Biointerfaces and Antifouling Polymers

Understanding the behavior of proteins, cells and bacteria at interfaces is key to effective design of materials that interact with biosystems. Quantitative protein adsorption experiments along with theoretical and simulation work performed in conjunction with our collaborators are guiding the design of new biomimetic antifouling polymers. New ways of anchoring the antifouling polymers onto surfaces are inspired by mussel adhesive proteins, and new degradation resistant and biocompatible polymer chemistries are being developed. These polymers are intended to be used for limiting biofouling of surfaces, such as cell, protein and bacterial adsorption onto medical implants and devices, but may also be useful in industrial, consumer and marine uses where minimization of surface biofouling is desired.

Nanoscience/Nanotechnology

We are exploring the development of nanostructured therapeutic biomaterials. Potential medical applications range from structural composites for bone/tooth repair to drug delivery, cancer treatment, and biomedical imaging. Projects include the development and medical

applications of sterically stabilized and functionalized inorganic nanoparticles, surface modification, and the use of self-assembling molecules to form nanostructured 3-D assemblies.

Selected Publications

H. Lee, B.P. Lee, **P.B. Messersmith**, *"A reversible wet/dry nanoadhesive inspired by mussel and gecko adhesion"*, Nature, 448, 338-341(2007).

H. Lee, S. Dellatore, W.M. Miller, and **P.B. Messersmith**, *"Polydopamine: multifunctional mussel-inspired chemistry for coating surfaces of any material"*, Science 318, 426-30 (2007).

H. Lee, N. Scherrer, **P.B. Messersmith**, *"Single Molecule Mechanics of Mussel Adhesion"*, PNAS, 103, 12999-13003(2006).

A. Statz, R. Meagher, A. Barron, **P.B. Messersmith**, *"New Peptidomimetic Polymers for Antifouling Surfaces"*, Journal of the American Chemical Society, 127, 7972−7973(2005).

J.L. Dalsin, B.-H. Hu, B.P. Lee, **P.B. Messersmith**, *"Mussel Adhesive Protein Mimetic Polymers for the Preparation of Nonfouling Surfaces"*, Journal of the American Chemical Society, 125, 4253-8(2003).

Awards & Honors

Langmuir Lecture Award from the American Chemical Society

Editorial boards: Nanomedicine, Soft Matter, Biointerphases, Biomedical Materials

Fellow, American Institute for Medical and Biological Engineering

MERIT Award, NIH

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