Shaoyi Jiang, Ph.D.
Boeing-Roundhill Professor of Engineering
Department of Chemical Engineering
University of Washington
Seattle, Washington 98195

Molecular Understanding, Design and Development of Ultra Low Fouling Zwitterionic Materials for Biomedical Applications

Abstract: An important challenge in many applications, ranging from medical devices to drug delivery, is the prevention of nonspecific protein adsorption on surfaces. To address this challenge, our goals are twofold. First, we strive to provide a fundamental understanding of nonfouling mechanisms at the molecular level using an integrated experimental and simulation approach. Second, we aim to develop biocompatible and environmentally benign ultra low fouling materials based on the molecular principles we have learned. Over the last several years, we have demonstrated that zwitterionic and mixed charge materials and surfaces are highly resistant to nonspecific protein adsorption, cell adhesion and bacteria adhesion/biofilm formation from complex media. Both simulation and experimental results show that the strong hydration of zwitterionic materials is responsible for their excellent nonfouling properties. Recent results show that zwitterionic materials induce no capsule formation upon implantation (Nature Biotechnology 2013) and no immunological response in blood circulation (PNAS 2015) and are able to preserve protein (Nature Chemistry 2012) and cell (Angewandte Chemie 2014) bioactivity. At present, zwitterionic materials, as alternatives to poly(ethylene glycol) (PEG)-based materials, have been applied to a number of applications, including implantable medical devices, early cancer diagnostics, drug/gene delivery, antimicrobial coatings, and marine coatings.