4q Studying Single Proteins at Interfaces Towards the Development of Integrated Systems
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The objective of my research is towards the goal of understanding interactions of biomolecules with synthetic surfaces and harnessing the power of optical techniques and single molecule strategies to develop systems that can be used to fabricate integrated devices for analyte detection. At a fundamental level, this research is geared towards understanding how biomolecules such as proteins or enzymes behave at interfaces while studying the intrinsic protein structure and dynamics. At the next level, knowledge of such interactions can be used to improve the design of existing systems and develop materials for biotechnology, biomaterials and nanotechnology.

My graduate research work focused on the fabrication and design of polymeric biosensor systems and the application of fluorescence techniques for the detection of analytes both within the body and the external environment. I worked primarily on using poly (ethylene glycol) hydrogel networks for such optical detection. As part of a broader research effort to create microfabricated total analysis systems, I also worked on the application of fluorescence polarization in immunological microfluidic device sensors.

My postdoctoral work at the National Institutes of Health has been part of an interdisciplinary intramural program that aims to use cross-disciplinary expertise towards tackling complex problems in biology and medicine. I am working on using self-assembled monolayers (SAMs) to fabricate model functionalized surfaces for understanding biomolecular interactions and protein patterning at a single molecule level. Techniques such as atomic force microscopy (AFM) were used to probe resolution on the level of a few nanometers and elicit structural and biophysical information about single muscle proteins. In particular, several key muscle proteins such as myosin, nebulin and fragments thereof were studied, as were their interactions with specific antibodies designed to recognize particular sequences in these proteins.

For my future research program, I plan to integrate surface chemistry, materials engineering and experimental tools with knowledge of proteins, their behavior and nanomechanics. Specifically, interfacial characterization tools, optical microscopy, fluorescence and atomic force microscopy can be used for a better understanding of how to build better, smaller and more efficient devices for a variety of tasks including label-free detection, immunoassays and bio detection, while contributing to basic understanding of protein structure and interactions at synthetic interfaces.