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Interactions of zwitterionic polymers with biomolecules at nanoscale

Monday August 1st
Lecture 4:00-5:00 p.m. | Physics/Astronomy Auditorium (PAA) A118
Reception 5:00-6:00 p.m. | Benson Hall Lobby

Bio

Syeda Tajin Ahmed received her B.S. in Chemical Engineering from Bangladesh University of Engineering and Technology in 2014 and Ph.D from the Dept. of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign in August 2021 with Prof. Deborah Leckband. She is currently a postdoctoral scholar at University of California-Merced in the Department of Materials Science and Engineering in Prof. Roberto Andresen Eguiluz group. Dr. Ahmed's research focuses on the interactions between zwitterionic polymers and proteins at nanoscale, the interfacial properties of zwitterionic polymers grafted on substrates, nature inspired wet adhesives, and tribology of synovial fluids. Apart from research, she enjoys doing outreach work as a member of the American Chemical Society and Society of Women Engineers.

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Abstract

In recent years, zwitterionic polymers have invoked a great interest among scientists for development of smart surfaces. Zwitterionic polymers have moieties possessing cationic and anionic group, which give them unique properties such as ultralow non-specific protein adsorption and biocompatibility when grafted on surface. Poly(zwitterions) have been exploited where surface chemistries are important e.g. for biosensors, biomedical devices, targetable drug deliver, tissue scaffolds where binding capacity of molecular recognition elements like antibodies is challenging due to non-specific protein adsorption. Furthermore, these polymers provide superlubrication (with coefficient of friction below 0.01) when used as a coating on artificial surfaces or prosthetics to improve biocompatibility. It is not well understood, why do the zwitterionic polymers interact with proteins in solution, but show ultra-low fouling properties when they are grafted on substrates?

To address this contradiction, in this study, we investigated the dependence of protein adsorption on the chain grafting parameters of polysulfobetaine (pSB): namely, the grafting density (σ), molecular weight and ionic strength. We compared the adsorption of PGK (phosphoglycerate kinase) and positively charged Lysozyme versus the scaled grafting parameter s/2RF Here, s is the distance between grafting sites, and RF is the Flory radius. With both proteins, plots of the adsorbed protein amount versus s/2RF exhibits a bell shaped curve, with a maximum near s/2RF ~ 1 and an amplitude that decreases with ionic strength. This behavior is qualitatively consistent with theoretical models for colloid interactions with weakly attractive, grafted chains. In such models, adsorption is controlled by competition between protein-segment attraction and osmotic repulsion, which prevents protein insertion into the brush. The results from this study confirm that proteins do adsorb to pSB thin films. They also suggest an underlying mechanism. Comparison with polymer models further identify design rules for grafted zwitterionic films that effectively repel proteins. Further, we also investigated the assembly of macromolecular components of the synovial fluid of articular cartilage on such lubricating brush layer of zwitterionic polymer *in vitro*. This findings dictate the proper integration of such artificial blood contacting surfaces. Such articular cartilage-mimicking technology, which is applied to obtain highly lubricating surfaces, is therefore suitable for preparing artificial knee/hip joint substrates.