MIT Chemical Engineering Department
Spring 2018 Seminar Series
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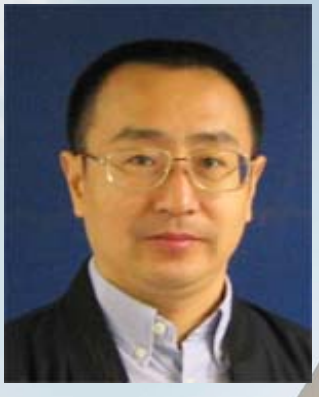
Anti-biofouling –How a polymer brush repels proteins and our novel integrated design



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Friday, May 11, 2018
3:00pm, Reception at 2:30pm
66-110

ABSTRACT: Grafting a layer of chains on a surface to form a polymer brush has been considered as an effective approach to make it anti-biofouling (less protein adsorption). The anti-biofouling property has been qualitatively attributed to the hydration of such a polymer brush with a layer of immobile water molecules and the steric effect; namely, the adsorption decreases monotonically as the polymer grafting density (s) increases. However, there is no quantitative and satisfactory explanation why the adsorption starts to increase when s is sufficiently high and why polyethylene glycol (PEG) still remains as one of the best to repel proteins. We have looked the captioned question from another angle: the entropic elasticity instead of the protein-surface interaction, i.e., the enthalpy change. Considering that each grafted chain is confined inside a cylindrical "pore/tube" made of its neighboring chains, as shown in the right figure, we found its optimal length by minimizing its free energy (*A*) that contains the exclude volume interaction and the chain elasticity (both of them have an entropic nature) [1, 2]; estimated how *A* depends on s and the chain length (*L*); and calculated its thermal energy-agitated chain conformation fluctuation that slows down the adsorption kinetically. After comparing *A* with the thermal energy, we are able to predict how both *L* and s affect the protein repelling and explain why PEG performs better than others. Our predictions are surprisingly and *quantitatively* comparable with those literature results [3, 4]. We will also illustrate how to develop some novel anti-biofouling coatings for shipyard/marine applications by using an integrated design that combines different existing strategies; namely, the self-polishing, the self-structure and the self-generated soft and dynamic surface [5, 6].