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Accidental Interactions and Purposeful Flaws in Polymer Brushes: Variations in Bioadhesive Mechanisms

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Water soluble brushes, such as polyethylene glycol and poly(hydroxyethyl methacrylate) are grafted, in many applications, to or from surfaces to prevent protein and cell adhesion. When brushes fail, as can be frequent in practice, protein adsorption becomes aggressive. Failure can occur if the brush architecture is simply too thin such that proteins can experience van der Waals and electrostatic attractions with the underlying substrate, or if the brush has flaws or holes, where the grafting procedure did not succeed. This talk compares the interactions of proteins and bacteria with nearly uniform brushes to the interactions of proteins and bacteria with patchy brushes. The latter are deliberately flawed by the inclusion of nanoscale adhesive elements (polymer coils and nanoparticles) at their base, which prevent local brush formation. The adhesive elements are smaller than the proteins themselves, but sufficient to perturb local brush structure. This talk demonstrates that large quantities of the appropriate types of random-coil (denatured) and globular (native) proteins can penetrate a brush and even displace it (if it is otherwise held in place by adsorbing anchor groups), while other proteins can be entirely repelled. The same is also true of the patchy brushes, but with patchy brushes, but the mechanism is different. With uniform brushes, small proteins and random coils sometimes penetrate sufficiently to experience electrostatic attractions once inside the brush. With patchy brushes, all proteins have the opportunity to interact electrostatically with the adhesive elements, but because large proteins can interact with greater numbers of adhesive elements, their capture is preferred. The result is different rankings of proteins which can ultimately adhere to thin uniform brushes or thicker patchy ones.