“Adhesive Strategies in Nature: Biointerfacial Designs Inspired by Mussels and Geckos”

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Nature provides us with a great variety of interesting adhesive strategies that operate in wet and dry environments and that can serve to inspire the development of new materials. Marine and freshwater mussels, for example, are famous for their ability to permanently adhere to a wide variety of wet surfaces, such as rocks, metal and polymer ship hulls, and wood structures. To accomplish this they secrete a series of byssal threads which serve to tether the mussel onto substrates. Located at the distal end of each thread is an adhesive pad containing specialized proteins collectively referred to as mussel adhesive proteins (MAPs). In this talk the composition, properties, and adhesive mechanisms of MAPs will be described. Single molecule force measurements are shedding light on the adhesive roles of key amino acids found in these proteins, and this information is being incorporated into designs of polymers for applications in wet environments, including polymer based adhesives for tissue repair. Another aspect of our work combines the adhesive strategy of mussel with that of gecko. In contrast to the mussel, gecko adhesion only works under ambient conditions and involves intimate but temporary contact between substrates and nanoscale hairs of the gecko foot. Recently the classic dry adhesive strategy of the gecko has been enhanced by coating synthetic gecko hairs with mussel mimetic polymer to allow temporary adhesion in wet environments. Finally, the use of adhesive peptides as surface anchors for immobilization of polymers on surfaces will be described. Here, synthetic polymers are grafted to inorganic and organic substrates through adhesive mussel-mimetic peptides, with the overall goal of mediating interactions with biological systems. Practical applications of these coatings include preventing cell, protein and microorganism (bacteria, alga) fouling of surfaces, and enhancing specific interactions between cells and surfaces.