Study reveals details of mussels' tenacious bonds

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When it comes to sticking power, marine mussels are hard to beat. They can adhere to virtually all inorganic and organic surfaces, sustaining their tenacious bonds in saltwater, including turbulent tidal environments. Little is known, however, about exactly how the bivalves achieve this amazing feat.

In a paper to be published online the week of Aug. 14 by the *Proceedings of the National Academy of Sciences*, a Northwestern University research team sheds new light on the adhesive strategies of mussels, information that could be used to develop adherents or repellants for use in medical implants.

This is the first-ever single molecule study to focus on the key amino acid 3,4-L-dihydroxyphenylalanine (DOPA), a tyrosine derivative that is found in high concentration in the "glue" proteins of mussels.

The researchers, led by Phillip B. Messersmith, associate professor of biomedical engineering in the McCormick School of Engineering and Applied Science, attached single DOPA amino acids to an atomic force microscope tip and measured the strength of interaction between DOPA and inorganic and organic surfaces.

They found that on an inorganic metal oxide surface DOPA interacts with the substrate by a coordinated noncovalent interaction, which is over an order of magnitude stronger than hydrogen bonding but still completely reversible.

On an organic substrate, DOPA can form even stronger, and irreversible, covalent bonds when it is oxidized by seawater. This helps to explain the remarkable versatility of mussels to adhere strongly to many different materials.

On neither substrate could tyrosine alone mimic such a strong binding interaction, which highlights that the modification of tyrosine residues to form DOPA during mussel glue processing is critical.

"Our results point the way toward new applications for our mussel mimetic polymers," said Messersmith, who has designed a versatile two-sided coating that sticks securely to a surface and prevents cell, protein and bacterial buildup. "For example, we may be able to take advantage of the reactivity of oxidized DOPA to form covalent bonds between adhesive DOPA-containing polymers and human tissue surfaces."

Source: Northwestern University