The underwater adhesion of marine mussels relies on mussel foot proteins (mfps) rich in the catecholic amino acid 3, 4-dihydroxyphenylalanine (dopa). As a side-chain, dopa is capable of strong bidentate interactions with a variety of surfaces, but its susceptibility to oxidation often renders it unreliable for adhesion. Mussels limit dopa oxidation by imposing an acidic, reducing regime in the confined space of mfp deposition. Using the Surface Forces Apparatus (SFA) technique, we demonstrate that the adhesion of mfp-3 to mica is closely coupled with dopa redox and pH. Raising the pH from 3 to 7.5 decreases the adhesion energy of mfp-3 on mica 20-fold and appears to be driven by the pH-dependent oxidation of dopa. Addition of thiol-rich mfp-6 restores mfp-3 adhesion by coupling the oxidation of thiols to the reduction of dopaquinones. How mussels preserve adhesive dopa-containing proteins from oxidation has considerable biological and technological value. [1], [2]

Figure 1: Redox control and the stepwise adsorption and cross-linking of mfp-3.

References: