Chemical Characterization and Polymer Mimics of Biological Materials From the Seas

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Marine organisms produce a remarkable diversity of materials with properties that are unmatched by today's current technology. One class of materials is the adhesives produced by mussels and oysters. Mussels secrete a soft protein-based material that contains high concentrations of the unusual amino acid 3,4-dihydroxyphenylalaine (DOPA). The catechol functionality of DOPA is known to promote both adhesive and cohesive cross-linking reactions leading to strong underwater bonding. We are developing synthetic styrene-based polymers containing pendant catechol groups for mimicking the cross-linking chemistry of DOPA-containing adhesive proteins.[1] Adhesion studies using an Instron materials testing system reveal that the synthetic mimics display very high adhesion strengths on a variety of surfaces and are capable of underwater bonding. Second generation polymer mimics containing cationic charge or poly(ethylene glycol) moieties have also been synthesized and their materials properties studied. In contrast, oysters produce a hard biomineralized adhesive material that is used to adhere themselves together as well as to surfaces for habitat construction, reproduction, and defense from predation. We are currently using a variety of analytical techniques including scanning electron microscopy, fluorescence microscopy, and infrared spectroscopy to study the composition and structure of oyster cement. We have found that oysters product an inorganic-protein hybrid material comprised of approximately 10% by weight cross-linked adhesive proteins in a calcium carbonate (aragonite and calcite) matrix.[2]

References

(1) Westwood, G.; Horton, T. N.; Wilker, J. J. *Macromolecules* **2007**, *40*, 3960.
(2) Burkett, J. R.; Hight, L. M.; Kenny, P.; Wilker, J. J. *Journal of the American Chemical Society* **2010**, *132*, 12531.