

“The mussel holdfast thread: A material worth mimicking?”

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From the ancient Greeks to modern soft matter physicists, the hair-like attachment fibers fabricated by mussels to anchor themselves firmly to their substrate have been a source of fascination. While some evidence suggests that the Romans used these holdfast threads as a commodity material for luxury togas, human utilization of the mussel's threads today is primarily as an inspiration for bio-mimetic design. In this talk I will give an overview of the current understanding of the molecular make-up of the 3 different materials constituting a mussel thread: 1) the inner core, 2) the outer coating and 3) the substrate adhesive. Focusing in particular on the coating, I will highlight how the mussel has maximized damage tolerance of these polymeric materials by spatially controlling energy dissipation on the nano-scale to minimize failure on the macro-scale. Furthermore, by studying this hierarchical material's structure and mechanics on multiple length scales, we have found that unique bio-polymer crosslinks also play a key role in providing the mussel thread its unique self-healing properties. A recently developed simple synthetic polymer material held together with these mussel-inspired crosslinks display complete self-healing thereby demonstrating that the mussel's holdfast threads are indeed worth mimicking.

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