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Mussel Adhesion is Significantly Enhanced Due to the Shape and Mechanics of Its Holdfast KENNETH DESMOND, NICHOLAS ZACCHIA, HERBERT WAITE, MEGAN VALENTINE, University of California, Santa Barbara — Mussels permanently adhere to surfaces through a circular plaque that is attached to the animal body via a long thin thread; forming a mushroom-shaped geometry. A plaque just a few millimeters in diameter with a 250-micron diameter thread can withstand large pull forces of a several Newtons without debonding. While the strength of individual chemical bonds plays a role in determining the adhesive strength, the contact mechanics associated with the mushroom shape is also critically important. In fact, numerous other organisms also use mushroom-shaped holdfasts to create strong bonds, suggesting the mushroom geometry is particularly effective for adhesion. To better understand the role of contact mechanics on the adhesive strength of mussels, we study mussel detachment using a custom built load frame capable of pulling on samples along any orientation and measuring the resulting force, while simultaneously imaging the plaque deformation and the glass-plaque interface. We will show that the holdfast shape improves bond strength by an order of magnitude compared to other simple geometries and that force-induced yielding of the mussel plaque improves the bond strength by another two orders of magnitude. These results show that by optimizing for contact mechanics, adhesive strength can be finely tuned for a particular application without changing the interface chemistry.

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