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Laboratoire PMMH
10 rue Vauquelin, 75231 Paris Cedex 05



Séminaire PMMH

Amphithéâtre Langevin (A4), Escalier N, 2^{ème} étage

Vendredi 13 novembre 2015, 11h00-12h00

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UCSB

Learning from nature : how mussels stick to rocks, and what it can teach us about material design

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. To better understand the role of mechanics and geometry on the adhesive strength of mussels, we study the detachment of the mussel holdfast from glass using a custom built load frame. This device is capable of pulling on samples along any orientation and measuring the resulting force, while simultaneously imaging both the bulk deformation of the plaque and the debonding glass-plaque interface. Using this device, we measure the bond strength, observe debonding initiation, and relate the load force to the bulk deformation of the plaque. We find that the shape of the mussel holdfast improves the bond strength by an order of magnitude compared to other simple geometries and that mechanical yielding of the mussel plaque further improves the bond strength by nearly two orders of magnitude as compared to the strength of the interfacial chemical bonds. Mechanical tests are complemented by ultrastructural studies using electron microscopy and neutron scattering. These reveal the internal structure of the plaque to be a dense interconnected network of pores, that may play important roles in stress distribution and energy dissipation through geometric rearrangements or fluid flow between pores. These results show that adhesive strength can be tuned without need for interfacial chemical modification, and suggest new pathways for synthesis of biomimetic adhesive structures.

Prochain séminaire : vendredi 20 novembre, Sushant Anand (MIT)
Programme des séminaires : www.pmmh.espci.fr, onglet *Séminaires PMMH*
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