a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

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MECH 493 project: Nonlinear mechanics in bioinspired fibrillar adhesives

Project type

Computational

Background

Many animals have the ability to traverse surfaces of any constitution and at any inclination. Researchers were able to attribute the remarkable climbing ability of some of these animals to highly specialized, nearly fractal, hair-like geometries on their feet. These 'climbing organs' were found to maximize contact with surfaces such that intermolecular attraction become substantial; meaning these animals climb by adhering to surfaces through van Der Waals forces.

Inspired by this finding, researchers then developed synthetic versions of these climbing organs called fibrillar adhesives. Unlike conventional adhesives, which deteriorate over time or with use, fibrillar adhesives are potentially infinitely reusable. This lends fibrillar adhesives naturally to applications where detaching is equally as important as adhering. Such applications include use in climbing robots, drones, and factory assembly line machines. Possibly the most important area of application however, is in vacuum environments such as in space where the deterioration of conventional adhesives is highly accelerated.

Research objective

Because fibrillar adhesives are a recent technology much remains to be learned about how their design can be optimized. Our group is interested in developing a computational framework to enable the optimization of fibrillar adhesive designs and we would like someone to contribute to the advancement of our model.

Specifically, the current model considers linear elastic deformations whereas the materials commonly used for fibrillar adhesives are non-linear. Furthermore, although viscosity has been considered in our previous investigations, we would like to consider it in more depth. Non-linear elasticity as well as viscosity is to be investigated in the context of improving or reducing adhesive strength. The hope of the project is firstly to uncover new insight into how fibrillar adhesives should be designed, but ultimately, we hope to be able to describe the general mechanics of fibrillar adhesives and establish a universal tool to inform their design.

Project goals

The following lists the projected milestones for the project:

1. Familiarization with the linear elastic model and reproducing previously published results in (preferably) MATLAB.
2. Implementation of an appropriate material model for non-linear elasticity and or viscosity.
3. A thorough yet focused computational exploration of emergent behavior resultant from 2.
4. The preparation of a report or paper draft which covers all the key developments and findings.

Facilities and team

As this is a computational project, it will be expected for the student to work on a computer, preferably his or her own laptop. However, if needed a computer can be provided. The student is expected to work from home and to interact with the rest of the research group.