Nature inspired fibrillar adhesives: Controlling adhesion with geometry and material gradients

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Abstract:

Most natural organisms are covered with hairy surfaces, which serve unique functions. In organisms like geckos and beetles, their hairy feet provide them with the amazing ability to scale practically any surface, independent of chemical composition and roughness. While synthetic analogues of these natural adhesives have shown great promise, two main features of the natural adhesives are yet to be matched: the high elastic modulus of the fibers and the ability of the gecko and others to scale rough surfaces. Recent discoveries suggest that the fibers forming these adhesive pads are of composite construction employing a gradient in elastic modulus and are curved rather the vertically aligned. I'll show how stiff composite fibers can be used to improve adhesion to rough surfaces, and how adhesion is related to layer thicknesses and roughness amplitude. I'll also show results from another type of composite fiber, resembling the joint like features in ladybird beetles, improving both adhesion and friction. Finally, high friction, low adhesion surfaces comprised of curved microplates will be explained. These surfaces can generate friction coefficients up to 6 with minimal adhesion, making them ideal for applications in semiconductor industry and mobile robotics.

Bio:

Dr. Aksak is currently an Associate Professor in Mechanical Engineering and the Director of Bioinspired Mechanics and Systems (BIOMS) Lab at Texas Tech University (TTU). Dr. Aksak earned his bachelor's degree in 2003 in Mechanical Engineering at Middle East Technical University. He received his masters and doctorate degrees in Mechanical Engineering from Carnegie Mellon University (CMU) in 2005 and 2008, respectively. He is a cofounder of two companies, a CMU spin-off nanoGriptech Inc. founded in 2009, and a TTU spin-off Flow Raider LLC founded in 2018. He has over thirty journal and conference publications. He is also an inventor on six issued, four pending, and one provisional patents. His research has been funded by agencies such as National Science Foundation, Department of Defense, and Air Force Office of Scientific Research. His main research focus is creating active and passive functionally layered structured surfaces to study adhesion and friction, tactile sensing, energy harvesting, and fluid-structure interactions.