A novel switching mechanism for adhesion

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Lizbeth Prieto-López, PhD student working with Professor John Williams in the Mechanics, Materials and Design division, is designing a novel switching mechanism for adhesion that uses Van der Waals forces.

The ability to control adhesion on demand is a feature that could find application in a variety of fields. For example, climbing robots require mechanisms that allow precise control of their adhesion to, and detachment from, a variety of surfaces. A major difficulty for such systems is the generation of adhesion to a counterface regardless of its nature (i.e. metallic, polymeric, ceramic etc.) and irrespective of its roughness. Lizbeth has found that by incorporating a fibrillar or "gecko-like" texture the functionality of her switchable adhesion surfaces can be effective even in contact with relatively rough counter-faces.

In the same way that a light can be turned "on" and "off" these special surfaces can be switched from being "sticky" to "non-sticky". This switchable adhesion is based on the deformation of the surface of a soft polymer. Changes in the surface of this soft polymer are regulated by the inflation of an array of small chambers that lie just underneath the surface and modify its shape when a hydrostatic pressure is applied to them. In their relaxed or default state, the soft polymer surface is comparatively flat so presenting relatively large areas ready to adhere to other objects. In this state they are "sticky", their adhesion relying principally on the operation of Van der Waals forces. When air pressure is applied to the subsurface chambers, the polymer becomes wavy, or bumpy, thus reducing the total area available to adhere to other counter-faces. In this state the surface is "non-sticky". So by controlling the pressure of the air it is possible to switch from one state to the other.

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