MAR10-2009-008246

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Mechanisms Underlying the Emergent Properties of Gecko-like Nanostructures[1]

KELLAR AUTUMN, Lewis & Clark

Imagine the difficulties a gecko would encounter if it employed a conventional pressure sensitive adhesive (PSA) on its toes. PSAs are soft viscoelastic polymers that degrade, foul, self-adhere, and attach accidentally to inappropriate surfaces. In contrast, gecko toes bear angled arrays of branched, hair-like setae formed from stiff, hydrophobic keratin that act as a bed of angled springs with similar effective stiffness to that of PSAs. We have discovered nine benchmark properties of the gecko adhesive over the past decade: 1) anisotropy, 2) strong attachment with minimal preload, 3) easy and rapid detachment, 4) material independence, 5) self-cleaning 6) anti-self-adhesion, and 7) nonadhesive default state. Most recently, we discovered 8) dynamic adhesion and 9) wear resistance. Rate dependent, wear-free friction and adhesion in a dry hard solid may emerge from uncorrelated stick-slip of the spatulae. We confirmed these predictions in a gecko-like synthetic adhesive (GSA) made from a hard silicone polymer. The GSA slid smoothly while adhering, and its velocity-dependence and stick-slip frequency matched the predictions of the model. There has been rapid progress in understanding the principles underlying these remarkable properties, and in applying the principles of gecko adhesion in the fabrication of GSAs. Properties 1-9 have all been achieved in GSAs (although not yet in a single material).

[1]Support: NSF-IOS-0847953, NSF-NBM-0900723.