

## Butterfly Wings and Gecko Toes

A close examination of the natural world has revealed examples of how conditions at the nanoscale affect what happens at the human scale.

Take, for example, the blue morpho butterfly. This butterfly's wings are a beautiful, shimmering blue, a color so bright that naturalists have reported seeing the flash of blue wings from a quarter of a mile away. You might think that such a vibrant color comes from blue pigment; but there is no blue pigment in the butterfly's wings.

In fact, microscopic studies have shown that the butterfly's wing is covered with tightly packed rows of clear scales. These clear scales form layers that reflect blue light. Each layer is 62 nanometers thick and the layers are 207 nanometers apart. This spacing is exactly what's needed to reflect that shimmering blue light. Spacing of other distances will reflect light of other colors. The interaction of light with these nanoscale structures creates the brilliant blue color of the butterfly's wings.



[Nanoscale hairs on the toes of a gecko help this lizard climb walls.]

Another natural example of how very small structures have very big effects can be found on the feet of geckos, lizards noted for their ability to run across walls and ceilings, sticking effortlessly to the slickest surface. On the bottom of each gecko foot are half a million microscopic hairs, each about one-tenth the diameter of a human hair. The end of each hair splits into hundreds of even tinier hairs, measuring just 200 nanometers across. When a gecko presses its foot down, these tiny hairs unfurl, pressing very closely against the surface.

When atoms or molecules are brought very close together, they are weakly attracted to each other. The attractive forces, known as van der Waals forces,



operate at the nanoscale so we don't usually notice them. But these forces, multiplied by the millions of hairs on the gecko's feet, hold the lizard to the ceiling quite securely.

The nanoscale characteristics of butterfly wings and gecko toes have inspired researchers to contemplate commercial products that make use of the same principles. Researchers at the University of Manchester's Centre for Mesoscience and Nanotechnology in the United Kingdom have developed what they call "gecko tape," a supersticky reattachable dry adhesive that uses synthetic hairs mimicking those on the gecko's feet. Researchers at cosmetic manufacturer L'Oréal are working to produce cosmetics that reflect brilliantly colored light like the blue morpho butterfly's wings.