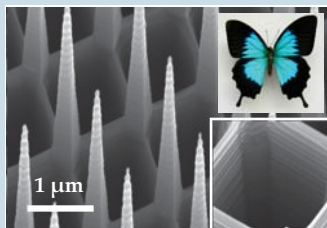


approach to understanding those processes is to quantify the degree of morphological change. Suppose, for example, you were presented with a collection of molars, one each from a number of related species. Establishing which teeth were most similar might provide insights into evolutionary dynamics. To facilitate the comparison, you could identify a limited number of cusps or other landmarks on the molar, as in the figure. Once each molar is reduced to some tens of landmarks, straightforward algorithms allow you to determine a scientifically useful, quantitative “distance” measure to express the similarity of any two molar surfaces. But placing the landmarks requires a practiced eye and possibly controversial judgments. To circumvent those difficulties, an international, interdisciplinary team led by Ingrid Daubechies has devised two new methods for defining a morphological distance between a pair of two-dimensional surfaces. Their algorithms consider the entirety of the surfaces—no special markers needed—and, importantly, can be speedily implemented on a computer. As one of several checks on the utility of their methods, the research team calculated the distances between each pair in a sample of 116 molars that had previously been analyzed with a conventional landmark-based technique. With impressive fidelity, both methods devised by Daubechies and colleagues reproduced the earlier results. (D. M. Boyer et al., *Proc. Natl. Acad. Sci. USA* **108**, 18221, 2011.) —SKB



Silicon meets the butterfly wing. Inspired by the nanostructures in the wing of a male *Papilio ulysses*, researchers have made a silicon wafer that both repels water and strongly absorbs light. Also known as the blue mountain swallowtail, the butterfly (shown in the inset) has multilayered structures in its wing that create multiple traps for both air and light. Air trapped on a rough surface is known to significantly reduce the frictional drag on a flowing liquid—a property known as superhydrophobicity (see PHYSICS TODAY, October 2009, page 16). But artificial superhydrophobic surfaces are usually unstable to capillary flows and other external perturbations and easily lose their trapped air. A multinational group led by Sang-Ho Yun (Royal Institute of Technology, Kista, Sweden) has now used standard micro-fabrication techniques to drill micron-deep pores in a silicon wafer and build nanocones on the pores’ edges as shown in the image. The production process took 10 minutes for a 10-cm wafer. Together with etched grooves and bumps on the walls, the arrays of cones and pores form a hierarchy of air traps that proved to be stable for a full year. Water drops bounce off the surface, and a fine mist bunches up into spherical drops that roll off. In addition, light at wavelengths longer than 750 nm is nearly perfectly absorbed. Together, those properties make the textured surface promising for integrated electro-optical devices, such as solar cells, IR-imaging detectors, cell culture devices, and chemical sensors. (S.-H. Yun et al., *Appl. Phys. Lett.*, in press.) —SGB



A marriage of microscopy and image compression. Instead of looking at a surface pixel by pixel, a new microscope takes a more global view to achieve improved resolution. The detailed chemical structure of a surface can reveal a

wealth of information about such processes as catalysis, corrosion, and wetting. One technique for getting at that surface structure is sum frequency generation (SFG), in which a pair of photons simultaneously strike a spot on the surface, interact with the material there, and convert to a single photon. Conventional SFG microscopes use a raster-scan; that is, they image the surface one pixel at a time. That approach has an inherent limitation: As the microscope samples smaller pixels to improve resolution, the intensity associated with each pixel drops, eventually becoming too small to measure. Now Steven Baldelli of the University of Houston, Kevin Kelly of Rice University, and colleagues have combined the mathematics of image compression with SFG to create a microscope that acquires less data than its conventional counterpart but generates an image with improved resolution. In the key step, the light emitted from the entire sample is focused onto a collection of tiny mirrors arranged in a random-looking pattern such as in the figure. Crucially, the light emanating from a particular pixel on the surface strikes a corresponding element of the mirror arrangement. The total intensity of the light reflected from the mirrors is then measured; it represents a type of dot product between the sample and the mirror state. It turns out that a relatively small number of such dot products suffices for faithful reproduction of the sample. Baldelli and colleagues used their proof-of-principle microscope to image 100-μm-wide gold stripes deposited onto silicon with a resolution of about 10 μm, significantly better than would be obtained in raster-scan mode. (X. Cai et al., *J. Chem. Phys.* **135**, 194202, 2011.) —SKB



Monitoring surface diffusion, one molecule at a time. The symmetry of a surface can influence the preferred direction in which adsorbed molecules may diffuse—their motion constrained either to particular sites or to one dimension, for instance, because of surface anisotropy. But the converse is also true: An adsorbed molecule’s symmetry can also influence its diffusion—sometimes dramatically. A University of Regensburg group led by Jascha Repp has now studied that converse situation using a scanning tunneling microscope to image copper tetraaza phthalocyanine adsorbed on an ultrathin film of sodium chloride. The organometallic molecule, pictured here, forms four distinct isomers that differ only in the position of the nitrogen atoms (blue) localized on each arm of the molecule’s carbon framework. The STM resolved the orbital configuration, and thus the symmetry, of each isomer and its position on the NaCl surface. Crucially, the STM also was used to trigger an isomer’s movement by injecting enough current for it to overcome the diffusion barrier. The microscope’s tip was positioned atop a molecule at constant voltage until a drop in current occurred, signaling lateral motion. By performing that experiment repeatedly for distinct isomers, the Regensburg team found specific patterns of movement, which allowed them to determine the different symmetry-specific diffusion behavior. (T. Sonleitner et al., *Phys. Rev. Lett.* **107**, 186103, 2011.) —RMW ■

