

made repeated measurements to monitor the characteristic time over which the spin-state oscillations decayed. That work now sets the stage for statistical studies that explore the link between an NV center's decoherence and local magnetic fluctuations in processes such as the charge transport through ion

channels in a cell membrane. Last year Hollenberg and colleagues calculated that ion-channel dynamics could, in principle, be detected with millisecond resolution by monitoring the probe's decoherence.⁴ The issue is not just academic; ion channels are important drug targets.

Mark Wilson

References

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Kinetic experiments shed light on protein-folding thermodynamics

Perturbing biomolecules and then watching them relax may be the kind and gentle way to determine their free-energy landscapes.

In its native state, the treasure trove of nutrients and biochemical machinery known as egg white is a slimy, translucent soup of proteins. Heat it atop a stove, however, and the proteins unfold, coagulate, and collectively morph into an opaque white solid. The unraveled proteins are said to have denatured. The enzymes among them, although well-suited for a cheese omelet, are in no shape to usher along biochemical reactions.

The proteins would have suffered a similar fate had the egg white been whipped into a foamy meringue or soaked in lime juice. Indeed, the precise biological work of folding a protein can be undone by any number of environmental stresses, including heat, acidity, and mechanical strain. Proteins, like all molecules, tend to adopt the shape that minimizes their free energy. In some circumstances, a compactly folded state makes thermo-

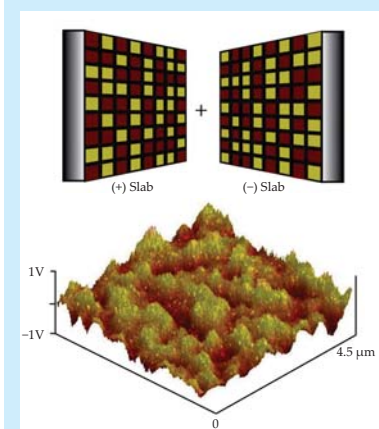
dynamic sense; in others, it doesn't.

To characterize the influence of environment on a protein's shape, biologists construct a free-energy landscape. They typically do so by performing titrations, experiments not all that dissimilar to frying an egg: A protein solution is subjected to a gradual ramp in some input variable—perhaps temperature, perhaps some other quantity—and monitored for physical changes indicative of folding or unfolding.

physics update

These items, with supplementary material, first appeared at <http://www.physicstoday.org>.

A nanoscale mosaic model of static electricity. Rub a balloon against your hair or rub any two nonconducting materials together, and as any high school physics student knows, the surfaces develop opposing static charges. Theoretical models of that process, known formally as contact electrification, have long assumed that the material properties of each surface are spatially homogeneous and that the post-contact charge distributions are uniform. If those assumptions were correct, then identical materials rubbed together should not transfer any charge. But



they do, as was demonstrated by Northwestern University researcher Bartosz Grzybowski and colleagues roughly two years ago with identical polymer slabs. They predicted then that charge is transferred through a random mosaic of oppositely charged sub-micron-scale domains, shown in the schematic, generated by inhomogeneities in the materials' surface properties.

Now, Grzybowski and other Northwestern researchers have experimentally verified the mosaic model by imaging contact-electrified polymer slabs with an atomic force microscope; the AFM-generated surface potential map shown here revealed multiple positively and negatively charged nanometer-sized domains. Probing further, the researchers found possible evi-

dence of surface inhomogeneities: Raman spectra indicated that some bonds were cleaved or oxidized, and x-ray photoelectron spectra of dissimilar polymer slabs that had been in contact revealed nonnative elemental peaks, which suggests material transfer. Their next goal is to probe other local surface properties to find out how bond breaking and material transfer influence domain size and overall charge. (H. T. Baytekin et al., *Science*, in press, doi:10.1126/science.1201512.)

—JNAM

Tantalizing and rare neutrino oscillation. The first appearance of electron neutrinos amidst an underground beam of muon neutrinos has been reported by Japan's T2K collaboration. The three "flavors" of neutrinos—electron, muon, and tau—can quantum mechanically swap identities in transit as long as all three neutrino masses are different. To date, those so-called flavor oscillations have been detected mainly by observing the disappearance, rather than the appearance, of neutrinos of a given flavor; the assumption is that some of the missing neutrinos changed identity en route from their source. Originating at the Japan Proton Accelerator Research Complex (J-PARC), the T2K muon-neutrino beam traveled 295 km to Japan's Super-Kamiokande detector, where 88 neutrino-interaction events were detected. Of those 88 events, 6 appear to come from electron-type neutrinos. Only 1.5 such events would be expected if the elusive flavor-mixing parameter θ_{13} were zero. The θ_{13} result, based on only 2% of the data originally expected from the experiment, is considered preliminary. But it is being published because J-PARC was damaged by eastern Japan's massive earthquake and tsunami on 11 March 2011 and will remain offline for many more months. If confirmed, the result will have profound implications: A nonzero θ_{13} makes possible CP violation with leptons, which might then explain the cosmic matter-antimatter imbalance. (K. Abe et al.: T2K collaboration, <http://arxiv.org/abs/1106.2822>.)

—SGB

Houston's structures thwart cleansing breezes. On 30 August 2000, as the Sun beat down on Texas's largest city, ozone