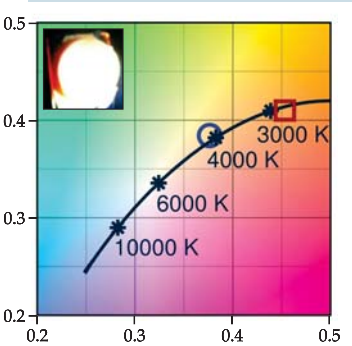
Physics Today

The breakup of Martian boulders

Charles Day

Citation: Physics Today **66**(9), 18 (2013); doi: 10.1063/PT.3.2108
View online: http://dx.doi.org/10.1063/PT.3.2108
View Table of Contents: http://scitation.aip.org/content/aip/magazine/physicstoday/66/9?ver=pdfcov
Published by the AIP Publishing

Lighting with laser diodes. Solid-state lighting continues to gain popularity as an efficient replacement for conventional incandescent and fluorescent illumination. The light sources typically combine an LED that emits in the blue or near-UV with one or more phosphors that are excited by the LED and emit at longer wavelengths. When an LED is driven at high current densities, however, its efficiency falls off steeply (see PHYSICS TODAY, July 2013, page 12) and the spectral outputs of the LED and the nearby phosphors shift. But as Kristin Denault, Michael Cantore, and colleagues at the University of California, Santa Barbara (UCSB), report, laser diodes are developing into an attractive alternative to LEDs. The coherent laser output doesn't droop or shift, and the phosphors can be placed far enough away and kept cool so that their spectral contributions also remain stable. In two of the UCSB devices, a commercial near-UV laser diode excited red, green, and blue phosphors. By varying the ratios of phosphors, the researchers produced one device that gave off yellow-tinted "warm" white light similar to incandescent light and another that gave off a bluer, "cooler" white (the square and circle, respectively, in the color plot; the inset shows the warmer output). Both produced excellent color rendering. Although their brightness was comparable to commercial white LEDs, the devices' respective luminous efficacies—the perceived light output per watt—were 16 and 19 lumens/watt, similar to that of halogen bulbs. A third device, incorporating a blue laser diode coupled to a yellow phosphor, reached 76 lm/W, comparable to many LEDs, but poorer color rendition than the triphosphor devices. The team expects that advances in laser-diode technologies and phosphor properties will further increase the efficacy and competitiveness of laser-based lighting. (K. A. Denault et al., *AIP Adv.* **3**, 072107, 2013.) —RJF



The breakup of Martian boulders. The meteorite bombardments and volcanic eruptions that scarred the surface of Mars ended billions of years ago. But weathering and erosion are still steadily reshaping the Martian surface. How quickly those processes occur is the topic of an investigation by Tjalling de Haas of Utrecht University in the Netherlands and his colleagues. To derive his estimate, de Haas exploited a system of four overlapping alluvial fans of widely different ages that spill from a crater in southern Mars. The fans, which consist of rocks of various sizes, formed in the same way as the terrestrial fan in the photo did: Water once carried debris down a slope whose abrupt reduction in gradient caused the debris to spread outward. Images taken by the HiRISE instrument aboard NASA's *Mars Reconnaissance Orbiter* reveal boulders as large as 5 meters on the youngest fan, but no boulders larger than the instrument's resolution of 0.25 meters remain on the older fans, presumably because they have since disintegrated. How long did that reduction in size of at least 4.75 meters take place? The youngest fan must have formed sometime before meltwater from the last Martian glaciers ceased flowing (0.4 million years ago). The second- and third-youngest fans, unlike the oldest, lack cratering; they must have formed sometime after the last bombardment (1.25 million years ago). The boulders' implied breakdown rate of at least 3.5 m/Myr is far higher than estimates derived from crater morphology and suggests the action of a substance known to accelerate weathering and erosion: liquid water. (T. de Haas, E. Hauber, M. G. Kleinhans, *Geophys. Res. Lett.*, in press.) —CD

The hard and soft of dense suspensions. A complex fluid, whether blood or mud, can exhibit a tremendous range of mechanical properties determined, among other things, by the liquid's viscosity, the particles' composition and chemistry, and the concentration of particles. Other effects being equal, whether the particles are hard or soft doesn't matter much at low or intermediate concentrations. But that should change at the highest concentrations, more in the realm of cosmetics (as shown here) than of paint. In a conceptually simple model with hard spheres (HSs), a particle's motion is confined to a cage formed by its nearest neighbors. As the concentration increases, the cage shrinks and motion decreases until, at a HS volume fraction of about 0.64, there remains no more available space for a particle to move. Soft spheres (SSs) are expected to behave differently—they deform each other at close quarters—but the details and implications of that behavior have been unclear. A team led by Peter Schall at the University of Amsterdam now provides a detailed experimental comparison of both types of complex fluid. The physicists applied an oscillating shear with steadily increasing amplitude to dense suspensions of either hard or soft spherical particles, while simultaneously imaging a small region with confocal microscopy. Among their findings: The shrunken HS cages eventually yielded to the shear and ruptured, after which the initially arrested material began to flow once again. In contrast, the SS material deformed more elastically and dissipated energy in long-range relaxation modes, which resulted in a much higher maximum cumulative stress prior to yielding. (K. van der Vaart et al., *J. Rheol.* **57**, 1195, 2013.) —SGB ■