Pinpointing solar-cell efficiency

Guided by a detailed theoretical model, a team of Stanford University researchers has squeezed a record performance out of a novel solar cell. Their prototype "point-contact" silicon cell recently achieved a 27.5 percent efficiency in converting concentrated sunlight into electricity. This is the highest efficiency yet attained by any photovoltaic device.

"This work is a real benchmark in establishing what silicon technology can do," says Don Schueler, solar programs manager at the Sandia National Laboratories in Albuquerque, N.M. "This efficiency is much higher than what was believed to be the practical, achievable efficiency just a few years ago."

"It has come the closest in performance to what we feel needs to be achieved for photovoltaic cells used in utility systems," says Edgar DeMeo of the Electric Power Research Institute (EPRI) in Palo Alto, Calif., a utilities-sponsored research center that funded much of the Stanford work. "What encourages us is that . . . it really looks like the cell can be made using techniques that are well established within the electronics industry for making integrated circuits."

The idea is to use lenses to concentrate sunlight onto small photovoltaic cells specially designed to operate efficiently in high-intensity sunlight. The point-contact cell has several features that make it particularly efficient.

First, each single-crystal silicon chip, about one-fourth the size of a postage stamp and only 0.1 millimeter thick, has a "texturized" upper surface to spread out incoming light. The mirrorlike lower surface helps trap light within the material so that more can be absorbed.

Furthermore, all of the surfaces have a thin silicon dioxide layer except at the points where the current is conducted out of the cell. This layer reduces the chance of light-ejected electrons recombining with the "holes" left behind. Otherwise, less current is generated. In conventional solar cells, both the top and bottom surfaces must be coated with conducting materials, which tend to increase such losses.

In the point-contact cell, a polka-dot pattern of tiny doped-silicon regions is scattered across the silicon crystal's lower surface just above the silicon dioxide layer. Fine aluminum threads that penetrate the silicon dioxide layer collect the current from each of these points.

"All of this combines to give us a much higher current from this cell than from a conventional cell," says electrical engineer Richard Swanson, leader of the Stanford group.

The only experimental photovoltaic devices that now come close to the Stanford cell's efficiency are ones made from gallium arsenide. However, gallium arsenide is much more costly and difficult to process. Commercially available silicon solar-cell panels without concentrators rarely exceed an efficiency of 12 percent.

The Stanford researchers are now refining their design to improve their cell's performance to the 29 percent level that their calculations show is possible. "In addition," says Swanson, "we're going to be working on ways of mounting the cell."

Meanwhile, EPRI is putting together a program to see if this solar cell can be manufactured at a sufficiently low cost. "It looks good," says DeMeo, "but we've got to be sure that we're not dealing with just a laboratory curiosity. It'll be three or four years before we know what we've got." If the initial investigations work out, then utilities may start testing the use of these solar-cell arrays for large-scale power generation.

"The improvement of efficiency from the 22 to 24 percent region, where we were a number of months ago, up to 27.5 percent is very significant," says Schueler. "It certainly brings down the overall cost per watt of electricity produced. And we're probably not at the end of what can be achieved yet." *— I. Peterson*

Hominid 'caches' get bone-wear boost

As scientists learn more about the formation of archaeological sites thought to have been used by early human ancestors, or hominids, the behavior of our ancient forebears becomes, paradoxically, less clear.

A good example is a new study by anthropologist Richard Potts of the Smithsonian Institute in Washington, D.C. After conducting the first analysis of bone weathering among animal remains at hominid sites, he reports that human ancestors transported the bones over a period of at least five to 10 years to several sites in Olduvai Gorge, Tanzania, dated at between 1.70 million and 1.85 million years old. Although hominids returned to the sites over a number of years, says Potts, investigators have no clear notion of how often meat was eaten at these spots, whether food sharing or other social activity took place and what proportion of bones were the result of hunting as opposed to scavenging.

The finding, published in the winter PALEOBIOLOGY, does support Potts's "stone-cache hypothesis," which holds that stone tools were kept at the Olduvai sites where foods were taken to be cut up or otherwise processed. The sites were frequented by various carnivores attracted to the leftovers, notes Potts, so hominids kept their visits brief. In contrast, he points out, modern hunter-gatherers typically occupy campsites or "home bases" for up to several months before moving on to another camp.

The stage was set for Potts to elaborate on the stone-cache hypothesis in 1978, when Anna K. Behrensmeyer of the Smithsonian Institution described progressive stages of decomposition due to weathering in the bones of large mammals found in East African savannas. These savannas, says Potts, are excellent mirrors of ancient conditions at Olduvai. Each stage was linked to open-air exposures of up to 15 years; by that time, bones tend to disintegrate if they are not buried. In a further test of modern remains, Potts studied 605 mammal bones from a spotted-hyena den in the same East African region. He found that small bones tend to weather more slowly because they are temporarily buried and then uncovered as hyenas trample the den floor. The weathering analysis of long bone shafts, however, provided the best picture of the gradual accumulation of bones in the den.

Thus, Potts zeroed in on long bone shafts from six Olduvai sites. Each site yielded 34 to 150 specimens. Using Behrensmeyer's stages of weathering, he found that bones at all of the Olduvai sites accumulated over at least five to 10 years, a time span similar to that observed in the modern hyena den. Among hyenas, observes Potts, the dens are mainly used as temporary feeding stations by adult foragers. Hominids, he says, may have followed a similar pattern.

Furthermore, Potts explains that Olduvai animal bones displaying all stages of weathering have previously been found to contain both the tooth marks of carnivores and the cut marks of hominid tools. "Evidently," he says, "hominids and carnivores modified bones over about the same period of time, as though over a succession of occupations or visits to each site."

This interpretation conflicts with the suggestion of anthropologist Lewis Binford that the Olduvai remains largely represent animal death sites rather than bone collections transported by hominids. Binford, of the University of New Mexico in Albuquerque, holds that hominids scrounged from carcasses abandoned by carnivores and consumed more bone marrow than meat (SN: 3/9/85, p. 155).

The next step in resolving the controversy over how hominids used the Olduvai sites, says Potts, is for scientists to develop testable hypotheses to explain why the hominids kept coming back to the same spots. *— B. Bower*