New Molecules Harness the Energy of Light

For Earth, the ultimate source of energy is the sun, which steadily showers this blue-green planet with energy-rich rays. Nature has evolved numerous systems for harnessing that energy, green plants and bacteria representing notable examples.

Chemists who wish to synthesize molecules capable of capturing and using light's energy face a formidable task. Speaking at last week's meeting of the American Chemical Society in New Orleans, two researchers described newly designed molecules that can put light's energy to work.

Karen J. Brewer, a chemist at Virginia Polytechnic Institute and State University in Blacksburg and her colleagues have fabricated an inorganic light-harvesting molecule. The new material, which they call a supramolecular trimetallic complex, uses sunlight to collect electrical charges.

"These molecules are catalysts," Brewer says. Absorbing two photons apiece, they use the energy to store two electrons, which can then spark further chemical reactions—for example, splitting water molecules to release hydrogen or making fuels.

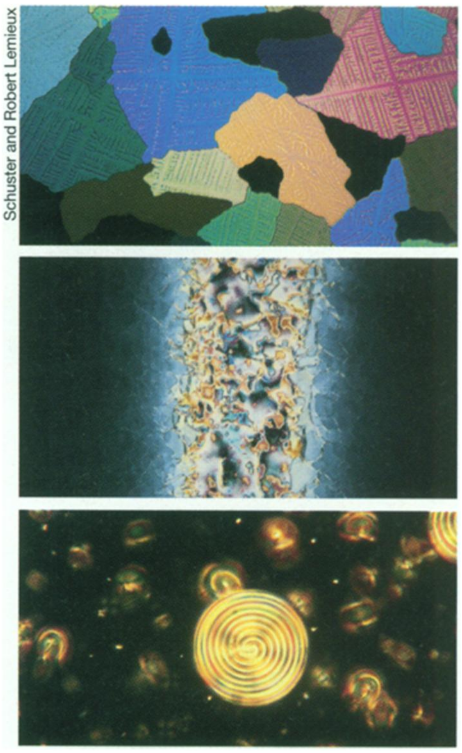
The method of transforming light energy into electrical potential borrows partly from green plants and partly from solar cells, Brewer says. In plants, chlorophyll molecules capture sunlight's energy and use it to break down carbon dioxide. Brewer says the new molecules also offer the potential to drive chemical changes, but they use inorganic materials more akin to those in solar cells than to those in plants.

While other groups have developed systems to store light energy in chemical form, most involve multiple molecules. In contrast, the new system represents the first inorganic synthetic molecule to use light to "store two electrons in a single place," Brewer says. This capacity improves photochemical efficiency, perhaps enough to make the synthesis of new types of fuel economically feasible, she says.

"Conceptually, the process is straightforward, but it's tricky to pull off with inorganic chemistry," says Thomas J. Meyer, a chemist at the University of North Carolina at Chapel Hill.

While mimicking photosynthesis, the new reaction's chemical energy is redirected toward novel ends, Meyer says. "Instead of making a woody structure and green leaf, you end up with energy-rich chemicals."

Directing light's energy toward a different goal, chemist Gary B. Schuster of the Georgia Institute of Technology in Atlanta and his colleagues have made a new class of liquid crystal molecules whose state and appearance change when they are exposed to light of different polarizations. By setting off a chain reaction in a liquid crystal material, the new molecules "act as triggers," he says, and may serve as a new type of optical switch.



Schuster and Robert Lemieux

When triggered by light, liquid crystals change phase, revealed by the different colors (top). A micrograph shows patterns formed by (center) and droplets of (bottom) the new material.

Once tripped optically, the molecules initiate a domino effect in the liquid crystals, leading potentially to a millionfold amplification, Schuster says. The new light-activated molecular switches might serve in three-dimensional arrays to store information. Potentially, this system could lead to rewritable, optically driven holographic memory devices.

By varying the polarization of light, one can "read, write, and erase information in this system," Schuster says. Such optical memories might eventually find their way into personal computers, videos, and music systems, increasing the data storage available in magnetic tape and compact discs.

The new phase-changing material might also find a home in spatial light modulators and coatings for optical fibers now used in computing, telephone, and television systems, Schuster says.

"The beauty of light beams," he notes, "is that you can cross them without making a short circuit." — *R. Lipkin*

Global positioning for all

The White House announced last week that civilians will be given access to extremely precise navigational information from military satellites sometime in the next 10 years.

"With a device the size of a calculator, more and more people will be able to use [the Global Positioning System (GPS)] to pinpoint their precise location—whether they're hiking across the Rockies or sailing across the Chesapeake Bay. Install this technology in the dashboard of a car, and drivers can figure out the quickest route to their destination," Vice President Al Gore said at a press conference.

The policy statement maps out a plan for free worldwide use of the GPS, a constellation of 24 Air Force satellites circling the globe. With GPS, U.S. military forces can locate their position to within 8 meters instantly. Scientists, airline companies, and other civilians currently receive an uncoded, but degraded, signal from the GPS satellites; this practice, in theory, limits accuracy to 100 m.

The Department of Defense corrupts the signal for national security purposes. The GPS could help enemy ground forces, ships, and aircraft navigate through war zones and could improve the accuracy of hostile missiles. But in a recent study commissioned by the White House, the RAND corporation of Santa Monica, Calif., noted that commercial firms have developed ways of improving the accuracy of the degraded GPS data to within a few meters, rendering this security measure less effective.

According to the new policy, the military will stop corrupting the GPS signal available to civilians in 4 to 10 years. Instead, the Defense Department will develop new ways of jamming enemy interception of GPS data.

The Clinton administration contends that free worldwide access to the positioning system will stimulate an already rapidly growing commercial market for GPS equipment, which is expected to reach annual sales of \$8.5 billion by 2000. — *R. Monastersky*