New Dye Adds Depth to Data Storage

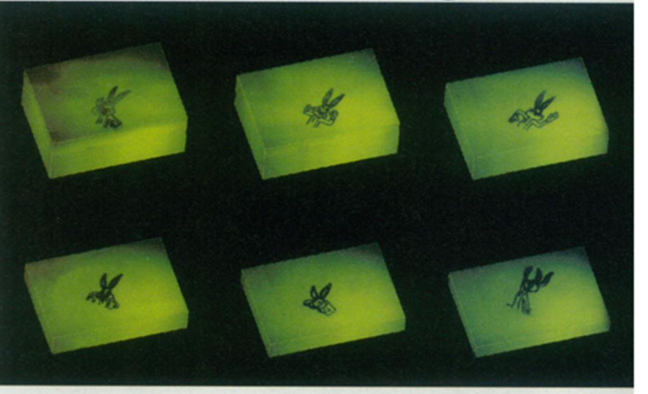
One cubic centimeter of a new material can potentially hold as much information as 1,000 CD-ROMs, researchers announced last week. The material, a transparent polymer impregnated with a specially synthesized fluorescent dye, achieves this capacity—1 trillion bits of data—by storing information throughout its volume instead of only on its surface.

Paras N. Prasad of the Photonics Research Laboratory at the State University of New York at Buffalo described the material on Aug. 27 at the American Chemical Society meeting in Orlando, Fla.

The idea of using dye-doped polymers as memory was proposed 7 years ago by Peter M. Rentzepis and Dimitri A. Parthenopoulos of the University of California, Irvine (SN: 9/2/89, p. 151). Since then, several groups have been developing these materials for commercial use and filing patents on aspects of the technology. Some of those scientists characterize the SUNY-Buffalo work as another step along the way to developing practical three-dimensional storage devices. The new dye Prasad described, says Watt W. Webb of Cornell University, "is one of many that have similar properties."

Exposing the polymer to high-intensity light changes the dye chemically, making it inert. Carefully controlled illumination by such light creates a pattern of dark and light spots throughout the material, resulting in a permanent, read-only memory.

Prasad et al./SUNY-Buffalo



Bugs Bunny gives a cheer in the frames of this minicartoon, each recorded on a different layer of a block of dye-doped polymer. The frames are stored in a space the width of a human hair.

Reading the data relies on the dye's fluorescence. When struck by light of an appropriate wavelength, a light spot emits a photon, while a dark spot does nothing.

The material can store data in three dimensions because the dye has an unusual property called two-photon absorption. A dye molecule emits a photon only after taking in two photons of half the energy. This property enables scientists to scan with lower-energy infrared light, which can penetrate the polymer, instead of higher-energy light, which cannot get below the surface.

Previously synthesized dyes, says Prasad, absorbed and emitted too weakly to be practical. "What we've done is make a new generation of highly efficient materials that can emit strongly."

Prasad claims that the new dye's greatly improved absorption and emission allow laser systems similar to those in current compact disc players to read the material. Modifications such as a pulsed laser source and a mechanism to scan in three dimensions would be needed, however.

The right dye should make it easier to surmount these limitations, he says. "It's one thing to calculate, and it's another thing to demonstrate. We've demonstrated a prototype system."

Webb, who holds a patent for a similar technique, says that "the dyes aren't limiting." He adds, "The reason it's not commercial now is that it needs a $100,000 laser [source]." Within 5 years, Webb predicts, there will be practical lasers for two-photon memory storage. — *C. Wu*

Feel like hibernating? Blame the brain

For many people, a nap by the fire makes even the worst cold weather bearable. For animals, however, surviving a winter often requires spending days on end at unusually cool body temperatures in a torpid condition.

What prompts animals to begin and end hibernation has long interested scientists. They knew that animals hibernate at predictable times, even under unusual lighting and temperature conditions. During that period, animals boost their body temperature to normal and rouse themselves for a day or so every 2 to 14 days. Yet the location of the internal clock thought to control these hibernation schedules remained elusive.

Now, Norman F. Ruby of Stanford University and his colleagues report that the brain's hypothalamic suprachiasmatic nucleus (SCN)—best known for its role in governing the body's daily rhythms (SN: 12/3/88, p. 366)—also regulates hibernation.

Ruby and his coworkers destroyed the SCN of eight golden-mantled ground squirrels (*Spermophilus lateralis*), which normally hibernate for 5 to 7 months a year. For 2 1/2 years, the team compared in the laboratory the hibernating habits of these animals to those of six intact squirrels.

The animals lacking an SCN roused themselves more often during their hibernation than the undamaged squirrels did, the team reports in the Sept. 3 Proceedings of the National Academy of Sciences.

In addition, although they initiated hibernation at the normal time, four of the altered animals hibernated for a month after the intact creatures emerged. The other four SCN-less squirrels cycled through bouts of torpor almost continuously throughout the study.

"That's phenomenal," said Brian M. Barnes of the University of Alaska, Fairbanks.

The continual hibernators may have suffered injuries to a region of the SCN that remained unharmed in the other four, the team speculates. The animals could also have suffered from injuries close to the SCN, adds Barnes.

Removing the SCN disrupted normal annual weight-gain cycles, Ruby says. The extended hibernators maintained lower weights than the other SCN-less squirrels, which had lower weights than the intact squirrels.

Loss of the SCN also disrupted the squirrels' circadian rhythms of activity; however, this had little influence on hibernation patterns, the authors assert. — *T. Adler*

Ruby

A wild golden-mantled ground squirrel filling its pockets before hibernation.