Materials Science

Red phosphors for 'green' fluorescents

A new material made by researchers at Utrecht University in the Netherlands offers a great two-for-one deal on light: After absorbing a single high-energy ultraviolet (UV) photon, it gives off two low-energy red photons. In combination with blue- and green-light-emitting compounds, this material could make practical more environmentally friendly fluorescent lamps.

A standard fluorescent bulb contains mercury vapor, which gives off UV light when stimulated by an electric current. The UV light excites luminescent materials known as phosphors that coat the inside of the bulb. The phosphors then reemit the absorbed energy as red, green, and blue photons, which combine to create white light. One UV photon yields one visible photon.

Researchers have tried to replace the toxic mercury with less-harmful xenon gas, with little success. Xenon emits higher-energy UV light than mercury and so, with currently available phosphors, wastes more energy. The one-for-one photon conversion doesn't produce enough light to be economical.

The new material, synthesized by Andries Meijerink and his colleagues, solves that problem by turning one photon into two. A gadolinium ion in the compound absorbs one UV photon, then transfers the energy sequentially to two europium ions. Each europium ion then gives off a photon of red light. The researchers report their findings in the Jan. 29 SCIENCE.

The Utrecht team is now determining whether the material will remain stable under the constant bombardment of high-energy UV light. The researchers are also trying to create blue and green phosphors to complement the red one. —*C.W.*

Polymers glow bright for 3-D displays

A group of commercially made polymers could form the basis of inexpensive displays that show objects in three dimensions, according to a new study. Such displays are in demand for applications ranging from medical imaging to air-traffic control.

Scientists have already devised three-dimensional displays that use a block of luminescent material that glows only when stimulated by two laser beams (SN: 10/26/96, p. 270). A set of lasers scanning the block can trace out a shape wherever they intersect, generating patterns like a three-dimensional Etch-A-Sketch. These prototypes, however, require expensive light-emitting glasses that are difficult to synthesize.

In the current study, Michael Bass and his colleagues at the University of Central Florida in Orlando tested several dyed polymers made by CYRO Industries in Orange, Conn., to see whether they would work for such a display. These brightly colored acrylics are widely used in fluorescent advertising signs and glowing children's toys, says Bass. He and his group found that the acrylics can indeed emit colored light when stimulated by a pair of infrared beams.

"This shows it's possible to make practical [three-dimensional] displays a reality and at a reasonable cost," says Bass. The Florida team reports its findings in the Jan. 18 APPLIED PHYSICS LETTERS. —*C.W.*

Enzyme churns out conducting polymers

Polymers that conduct electricity can form the basis of lightweight, inexpensive batteries and electronic components. Their complicated synthesis using organic solvents limits their practicality, however. Now, researchers at the University of Massachusetts in Lowell and the U.S. Army Soldier and Biological Chemical Command in Natick, Mass., have developed a simple way to synthesize a conducting polymer called polyaniline. The one-step, water-based method could be a cheap, environmentally benign way to make polyaniline on an industrial scale.

The researchers use an enzyme to construct the polymer from its building blocks. They describe their method in the Jan. 13 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY. —*C.W.*

Technology

From Washington, D.C., at a research workshop sponsored by the Bioelectromagnetics Society

Low-voltage gene transfer

Biotechnologists often employ an electric current to punch a tiny hole into a cell through which they can then insert a foreign gene. The high voltages and currents typical of this procedure, called electroporation, can heat the treated cells, however—often damaging or killing all but 10 to 30 percent of them, notes Robert E. Schmukler of Pore Squared Bioengineering in Rockville, Md. By redesigning the environment in which electroporation occurs, he's been able to drop the current to one-thousandth of what had previously been needed. This "kinder and gentler" approach boosts cell survival to at least 93 percent, he reports.

The trick, he found, is to use a thin film of an electrically insulating material perforated with tiny holes around 2 micrometers in diameter. He bathes the film in a solution containing the foreign genes, then spreads the cells to be treated across the top. When he applies a weak vacuum to the underside of the film, suction draws a tiny fingerlike projection from each cell into a different hole. Then Schmukler switches on a roughly 10-volt potential between electrodes above and below the film.

Because the film doesn't conduct electricity, the current is drawn through the holes, each now filled with a piece of a cell. The electric field inside the film's narrow holes rises almost 1,000-fold, easily reaching the magnitude necessary to open a pore at the tip of each cell's projection. This breach allows some of the gene-laden solution to enter. Because the current remains low, around 25 milliamperes, little heating occurs.

Schmukler has tested a prototype of his patented system with two different genes and two different types of mammalian cells. In a separate test-tube experiment designed to emulate gene therapy in an animal tissue, he has used this porous-film system to insert genes for a fluorescent enzyme into a living heart vessel. Proof that the technique worked was visible 3 days later, when the new genes caused the vessel's cells to emit a green glow. —*J.R.*

Microwave mammography

Most women over the age of 40 are intimately acquainted with mammography, which uses X rays to hunt for breast tumors. This potentially life-saving procedure is uncomfortable under the best of circumstances—which is why William T. Joines thinks women may warm to a microwave alternative.

The system that he's developing at Duke University in Durham, N.C., aims to locate mammary tumors with at least the same resolution as today's diagnostic devices. Yet because there's no need to tightly compress the breast during imaging, the risk of pain or bruising would be eliminated. Women "should feel nothing," Joines says.

His technology relies on the fact that microwaves respond somewhat differently when passing through healthy tissue and tumors. Compared with an equal volume of healthy breast tissue, a tumor not only dissipates about six times as much of the signal's energy, but also slows the signal's passage.

As Joines envisions the new procedure, a women would lie face down on a table with a cutaway section containing a well of warm fluid. This liquid, which could be a mix of salt water and alcohol, mimics healthy tissue's ability to transmit a microwave signal. Once a breast is immersed in the liquid, a small transmitter would send a beam of microwaves into the well. An array of detectors surrounding the container would then monitor the signal, triangulating any points where the beam slows or weakens—spots that might pinpoint cancers.

In tests using materials that mimic the microwave-signal attenuation and velocity in normal tissue and tumors, the system detected modeled tumors just 2 millimeters in diameter. Joines hopes soon to begin validation tests using tissue from breast-surgery patients. —*J.R.*