Hydrogel Adheres to Skin, Speeds Healing

A biomaterial, hydrogel, has been developed by researchers at Purdue University. This flexible, rubbery gel, consisting of about 80% water, is similar in composition to human skin. The only other ingredient in the hydrogel is a polymer called polyvinyl alcohol, or PVA.

Medicine, such as a healing agent, can be added to the material during the manufacturing process. In a clinical setting, a doctor would apply a patch of the drug-containing material to a wound, covering it with a bandage.

Nicholas Peppas, the Showalter Distinguished Professor of Biomedical Engineering at Purdue, said, "Most biomaterials made out of polymers, such as artificial veins and other types of patches, need to have chemicals called crosslinking agents or curing agents added during their manufacture in order to hold them together so that the polymer does not dissolve into the body. All the unreacted chemicals must later be thoroughly washed out of the biomaterial, because if they leach out into the body, they can be toxic. While the current materials are certainly safe, we avoid any possibility of leaching impurities because we don't add potentially toxic materials in the first place."

The procedure Peppas developed to make the bioadhesive relies on a freeze/thaw process. The polymer is mixed with water, then poured into flat molds and frozen and thawed in several cycles. During this process, a certain amount of the polymer crystallizes, which allows the material to maintain its solidity while being flexible and elastic.

SBIR Update

Essential Research, Inc. (Cleveland, Ohio) has been awarded a Small Business Innovation Research (SBIR) grant from the Ballistic Missile Defense Organization (BMDO). The grant will fund research and development of a solar-driven, thermophotovoltaic (TPV) electric power generation system. The Phase II award provides $600,000 of funding for the 24-month effort.

Advanced Refractory Technologies, Inc. (Buffalo, New York) has received a Phase I SBIR grant from the Wright-Patterson Air Force Base for "Data Acquisition for *In Situ* Materials Process Modeling," which is a proposal to create neural networks between the process parameters and the film properties.

Because the hydrogel is mostly water, when in use it needs to be in contact with a moist surface, such as a wound, and covered so that it will not dry out. It can be stored in water or dried to be stored and rehydrated for later use, Peppas said. He estimates the material can be stored for about six months. Peppas, presenting information on the material in November 1996 at a meeting of the American Institute of Chemical Engineers, said the primary application of the bioadhesive is for delivering drugs to an external wound not associated with an operation, such as a knife gash or other nonsuperficial wound that would be treated by a doctor.

The material's strength and elasticity are fairly constant in water from about 60°F (15°C) to about 122°F (50°C); but in water above 122°F (50°C), the crystalline structure begins to break down and the gel dissolves. "This should not be a problem when the material is used for the application of delivering drugs to an external wound," Peppas said.

CO_2 Turns Fly Ash into Building Material

Researchers at Los Alamos National Laboratory are developing an environmentally friendly process that hardens cement and creates a class of strong and lightweight building and fabrication materials. The process transforms common portland or lime cemented materials and clays by treatment with carbon dioxide under high pressure, making them chemically stable, nearly impermeable, and stronger. The process also makes inexpensive building products out of waste materials, including fly ash from coal-burning power plants, alum sludge from water treatment plants, and blast furnace slag.

Under increasing pressure and temperature, carbon dioxide gas first reaches a liquid phase, then enters a "supercritical" region where it has useful properties of both gas and liquid. Supercritical carbon dioxide expands to fill its container and diffuses into the tiniest pores like a gas. On the other hand, because supercritical carbon dioxide has a high density like a liquid, it can dissolve substances and carry them. In this case, it grabs water molecules and pulls them out of the cement. Chemically, the process converts the hydroxide of cement to a carbonate, with water as the byproduct.

Using supercritical carbon dioxide through a high pressure nozzle, large surfaces of existing concrete structures might be hardened and sealed against penetration of chemicals, improving wear-resistance and durability. The treated surfaces will resist chipping or scaling because the transition from the thin, very hard exterior to normal strength interior concrete would be gradual.

Since supercritical carbon dioxide readily dissolves many polymers, the process can be used to drive polymers into the surfaces of products made from cements, ceramics, or other water-based pastes. Polymer-impregnated structures are good for resisting shock and impact forces.

Optical Sensor Measures Average Wind Direction Over Long Distances

A single-ended, long-path laser wind sensor registers faint wind movements that an anemometer cannot measure. All optics and electronics are mounted on a large telescope. An inexpensive helium neon laser about two inches in diameter projects a beam of light from this unit onto a target approximately 100 feet away. The target is made of retroreflective materials used on highway signs. The telescope collects laser light reflected by the target, and sends it through the series of optics. Among those optics are two horizontally separated detectors, each of which monitors a spot on the target inside the laser beam. The detectors pick up shadowy waves, or fringes, moving across the laser beam. The waves are visible on the target material, said research scientist David Roberts of the Georgia Tech Research Institute.

"The fringes look a lot like the shadows of waves created on the bottom of a swimming pool," Roberts said. Each of the two detectors in the sensor registers the moment at which a dark fringe passes its view. By digitizing the points at which each detector picks up a single wave, a computer can measure time and separation. It then can compute the average velocity of a massive column of air crossing the laser beam. In this case, wind speed calculations were made every 10 seconds by the resesearch team at the Electro-Optics, Environment and Materials Laboratory.

"Even though air may be flowing erratically—some going one direction at one end of the beam and some going exactly the opposite direction—you can get a net flow across the laser beam with this method," Roberts said.

The sensor correlated extremely well with anemometer readings in test results with 100 feet between the sensor and the target. A 5% discrepancy, within the limits of experimental error, was observed between wind speed measurements by the sensor and by the anemometer in laboratory tests.

The sensor is easier to use than Doppler

https://doi.org/10.1557/S0883769400032917 Published online by Cambridge University Press

systems, the researchers said. In addition, it measures wind across the beam of light instead of along the beam, as Doppler systems do.

A poster paper on this work was presented at the International Symposium on Optical Science, Engineering and Instrumentation in Denver during August. The work was funded under the GTRI Internal Research Program.

Electron Described as Fuzzy Cloud Surrounding Core

According to recent measurements by Purdue University physicists, an electron may not be a simple negative point charge, as scientists often describe it. The researchers collided very-high-speed beams of particles at a facility at the Japanese Laboratory for High Energy Physics. David Koltick, professor of physics at Purdue, said that the electromagnetic force from the electron, or its electronic strength, may increase toward the particle's central core.

According to his data, surrounding the electron's core is a fuzzy cloud of virtual particles, which wink in and out of existence in pairs. One particle in the pair is positively charged, the other negatively charged. The cloud is polarized, which means that the strong negative charge at the core "pushes" the negatively charged particle in a pair slightly farther away from the core than the positively charged particle. The polarization is strongest toward the center of the core.

The polarized pairs essentially cancel each other out so that they do not add any net electric charge to the electron, Koltick said, but the cloud plays a key role in how the electromagnetic force from the electron is perceived.

"The cloud of virtual particles acts like a screen or curtain that shields the true value of the central core," Koltick said.

The researchers also determined that the strong nuclear force, which is the glue that holds together elementary particles such as protons, gets weaker closer to the core charge.

"Because the electromagnetic charge is in effect becoming stronger as we get closer and the strong force is getting weaker, there is a possibility that these two forces may at some energy be equal," Koltick said.

Chinese Academy of Sciences Elects Members

In June 1996, 10 foreign members were elected into the Chinese Academy of Sciences (CAS). Among the new members are **Robert W. Cahn** of the University of Cambridge, England (materials science); **A.Y. Cho** of AT&T Bell Lab, USA (semiconductor research); **C.W. Chu** of the University of Houston, USA (superconductor research); and **Y.R. Shen** of the University of California at Berkeley, USA (solid state physics).

CAS began inducting foreign members in 1994. To date, 24 have been selected.

Lyle H. Schwartz Named President of Associated Universities, Inc.

Lyle H. Schwartz, director of the Materials Science and Engineering Laboratory at the National Institute of Standards and Technology (NIST), has been named President of Associated Universities, Inc. (AUI). His acceptance was announced by Paul C. Martin, Chair of AUI's Board of Trustees and Dean of Engineering and Applied Sciences at Harvard University.

Associated Universities, Inc. is a research management organization chartered in 1946 as an independent, non-profit, scientific, and educational corporation. AUI operates Brookhaven National Laboratory under contract to the U.S. Department of Energy and the National Radio Astronomy Observatory under a cooperative agreement with the National Science Foundation. Its founding institutions are Columbia University, Cornell University, Harvard University, Massachusetts Institute of Technology, Princeton University, The Johns Hopkins University, University of Pennsylvania, University of Rochester, and Yale University.

Schwartz has played a significant role in shaping government policies on many materials issues. During the Bush administration (1989–1992), Schwartz led the multiagency Advanced Materials and Processing Program that identified and analyzed federal research and development materials science and engineering activities amounting to $2 billion. He currently chairs the multiagency Materials Technology Committee responsible for developing the materials agenda for federal government/ industry programs in support of automotive, electronics, aeronautic, building and construction, and environmental sustainability. Under his leadership, the pre-standards research organization (VAMAS) of the International G7 was brought to fruition as a stand-alone continuing activity among the member nations. □