Pilot-Scale Bioreactor Detoxifies Carcinogenic Compounds

Cornell University agricultural engineers have developed a bacteria-based reactor that can completely break down toxic chlorinated solvents in ground water to common salt, carbon dioxide, and water, rendering highly contaminated water drinkable.

The method works rapidly and efficiently even at low (ground-water) temperatures, and could be scaled up to clean up sites polluted by industrial chemicals such as tetrachloroethylene (perchloroethylene, PCE) and trichloroethylene (TCE), said William Jewell, who designed the bioreactor. While other cleanup technologies depend on long-term isolation or dilution, this biodegradation process detoxifies the carcinogenic compounds.

The hybrid reactor can, for example, reduce the concentration of PCE from 10,000 ppb to less than 1 ppb. Environmental Protection Agency drinking water standards require fewer than 5 ppb.

The bioreactor is small enough to fit on the back of a truck. An "expanded bed" keeps bacteria attached to small granules on a film, preventing them from being washed away by rapidly flowing water.

The detoxifying bacteria had previously been identified, but it is Jewell's use of a two-tank expanded bed that demonstrates complete biodegradation of chlorinated solvents. The first tank uses anaerobic bacteria to partially break down the toxins, while the second uses aerobic bacteria to finish the treatment.

In the first process, sucrose provides the anaerobic bacteria with the energy they need to strip the chlorine off the PCE and TCE, thereby breaking the chemicals down to vinyl chloride (VC), which is extremely toxic and highly volatile. The biodegradation process is completed by aerobic bacteria called methanotrophs which go to work after methane gas is pumped into the process. Absorbing the methane, the methanotrophs put oxygen in the VC compounds. The compounds then become susceptible to the microbes and break down into water, carbon dioxide, and harmless chloride ions.

The system works efficiently in water even as cold as 50°F, although the bacteria take longer to grow at this temperature.

The technology is currently being scaled up to process 40,000 gallons of water per day by the Department of Energy's Savannah River Westinghouse Corporation as a pilot test this year.

Norton Gets $14 Million-Plus for Diamond Research

Over the last year, Norton Company's Diamond Film Division has been awarded five research contracts worth more than $14 million for diamond film research for defense applications. Working with U.S. government researchers, Norton scientists are looking both at manufacturing processes and at specific products.

Two contracts funded by the Defense Advanced Research Projects Agency (DARPA) are dedicated to improving manufacturing processes for freestanding diamond products. The research program focuses on electronic substrates. Funding from DARPA through the Office of Naval Research is being used to develop better control sensors for Norton's manufacturing processes. Research to grow diamond faster by increasing the deposition rate and to finish diamond products more efficiently is also being supported to help make the transition from pilot-plant manufacturing to large-scale production.

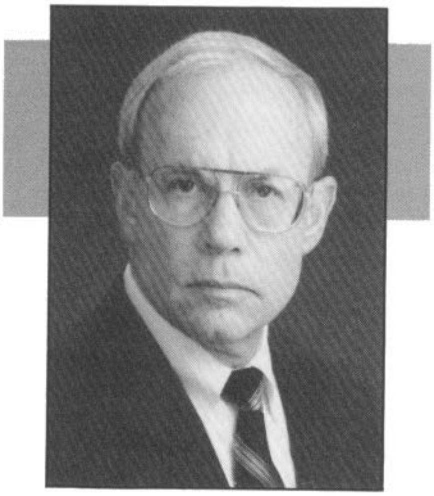
Norton is also working with General Dynamics and Martin Marietta to perfect the use of chemical-vapor-deposition (CVD) diamond for navigational windows on military aircraft. A contract with the Naval Weapons Center calls for Norton to develop freestanding diamond, several inches in area, to facilitate the transmission and reception of radar and communications systems.

In addition, Norton is involved in optical research for the Strategic Defense Command, studying possibilities for improving optical characteristics of several materials used by the Army by coating them with diamond film.

Government contracts also support Norton's development of CVD diamond for multichip module (MCM) applications, taking advantage of diamond's ability to dissipate heat, a necessary requirement for the next generation of high power computers. Using electronic substrates made from freestanding diamond would allow more densely packed MCMs, including three-dimensional interconnects.

Leamy Heads UNC-Charlotte Research Center

Harry J. Leamy has taken a position as director of the C.C. Cameron Applied Research Center and associate dean of engineering for research at the University of North Carolina at Charlotte. Previously with AT&T Bell Laboratories, Leamy took the new position March 23.



The Cameron Research Center, dedicated last September, will focus on interdisciplinary research for engineering and science students and faculty as well as visiting researchers from industry and academia. The Center is connected to the campus' local area computer network, a broadband communications system, and the North Carolina Supercomputer Center's Cray machine. The laboratories are designed to accommodate quick physical modification as projects change. Research areas include computer integrated manufacturing, metrology, nanotechnology, intelligent systems, integrated optics and signal processing, optical interconnects and computer-generated holography, molecular beam epitaxy, clean room technology, thin films, biotechnology, and transportation.

Leamy, president of MRS in 1984, has also served the Society as a committee chair, and as a member of the *MRS Bulletin* Editorial Board.

Wet Compresses Used to Desalinate Stone Monuments

Researchers at the Otto Graf Institute for Materials Research and Testing, Baden-Württemberg, Germany are using wet compresses to desalinate architectural and archeological stone surfaces. While sulfate compounds do not leach well due to their low solubility, the researchers found that between 80 and 90% of the easily soluble nitrate and chlorine compounds can be removed, although this is not as much as was expected.

A cellulose compress with a high water content, or a compress coating made of fatty marsh lime, is applied to the stone, triggering an osmotic flow of salt ions from the stone to the salt-free compress. When the salt concentration between the compress and the stone is equalized, a fresh compress is put in place.

Problems still remain. Migration of nitrate and chloride salts may be slowed or blocked due to deposits on pore walls or if low-solubility salts interfere. Also, if the compress dries, salt ions can migrate back to the stone. Further, the stone surface must be moistened beforehand and the compress pressed tight against the stone to maximize desalinization.

From *Special Science Reports, German Research Service,* **VIII**, No. 01/92, p. 9.

Alfred Signs Glass Research Agreement with Russian Academy of Sciences

Alfred University's Institute for Glass Science and Engineering has signed an agreement for collaborative research with the Institute for Silicate Chemistry of the Russian Academy of Sciences, St. Petersburg. The agreement also provides for the establishment of faculty and student exchange programs, joint sponsorship of courses, lectures, and seminars on topics of common interest, and the preparation and publication of papers on the results of scientific research.

New Milestone for Green Laser

A brightness milestone for laser light in the green region of the spectrum has been reported by researchers at the GE Research and Development Center. The 52 W beam generated by the GE team more than doubles the previously published brightness record for green light produced with solid-state lasers.

To achieve the high-brightness green light, the GE researchers began with a commercially available solid state laser that produces a beam with average power of 16 W and good quality in the infrared part of the spectrum (1.064 μm). After passing through several optical elements, the beam was fed into a specially built Nd:YAG (neodymium-doped yttrium-aluminum-garnet) face-pumped laser, amplifying the beam to 92 W while retaining good beam quality.

This beam was then passed through a focusing lens and fed into a "frequency doubler"—a crystal of lithium triborate—that halved its wavelength to 532 nm, producing the 52 W green beam in combination with an infrared beam. To separate them, the two beams were passed through a dispersing prism.

The green beam alone or in combination with infrared is well-absorbed by certain polymeric composites and might be suited for cutting, drilling, or other machining operations. Also, since seawater is essentially transparent to a green laser, it might be useful for underwater detection and communications applications involving submarines.

Charles Duke Named Editor of Surface Science

Charles B. Duke, senior research fellow at Xerox's Webster Research Center, was named editor of *Surface Science,* which has become a joint publication of Xerox Corporation and Elsevier Science Publishers, Amsterdam.

Surface Science, first published in 1964 by North Holland Publishers, is an international journal dedicated to the physics and chemistry of materials surface phenomena, including those of importance to the reprographic and the photographic film industries. The editorial office will be relocated from Boston to Xerox's Joseph C. Wilson Center for Technology, Rochester, NY, but the journal will be published in Amsterdam.

Founding editor of *Journal of Materials Research,* Duke is treasurer of the Materials Research Society and a past president of the American Vacuum Society. He also served as chairman of the editorial board of the *Journal of Vacuum Science and Technology*.

Duke is an originator of the theory of low-energy electron diffraction, used to determine the atomic structures of materials surfaces. He also leads an international consortium of researchers credited with determining the structures of many semiconductor surfaces and interfaces. For this and other work on the surface properties of organic materials, Duke received the 1977 Medard W. Welch Award in vacuum science and technology.

Kodas Receives Presidential Young Investigator Award

Toivo Kodas, assistant professor of chemical and nuclear engineering at the University of New Mexico (UNM), is one of about 200 scientists and engineers in the United States to receive a National Science Foundation (NSF) Presidential Young Investigator Award. The award provides research funds for five years and national recognition for potentially outstanding faculty members at the beginning of their careers. The foundation awards winners $25,000 outright per year, and then will match up to $37,500 a year received in grants from private sources.

Kodas' research interests include synthesizing and processing superconducting and conventional powders into ceramic materials that can be formed into wires and tapes, or grown by aerosol methods or chemical vapor deposition. He also uses CVD to deposit thin films of copper and other metals for microelectronic applications.

With a colleague at IBM, Kodas also developed an optical technique to measure rates of laser-induced chemical vapor deposition. The method uses lasers to introduce energy into localized places on ceramics, metals, or semiconductors to enhance depositions of metals there.

Known for his interest in teaching, Kodas includes undergraduate students in his research to encourage them to obtain graduate degrees, and he visits local high schools to encourage students to pursue degrees in science and engineering.

Archaeologists Use Microanalysis to Study Ancient Ceramics

Ian Whitbread and other researchers at the Center for Materials Research in Archaeology and Ethnology at the Massachusetts Institute of Technology are using computer-aided microanalysis to study ceramics and other archaeological materials.

Most archaeologists date and describe ceramics by their original size, shape, and applied decoration. But such analysis alone tells little about how a pot was made, or what it was made from—information that can tell a great deal about the society in which the pot was created. For example, Whitbread said, geological analyses of ceramic shards from Lerna, Greece, a Middle Bronze Age site, showed that the settlement once imported a great many goods from the island of Aegina because many of the ceramic shards found at Lerna contain volcanic rock peculiar to Aegina.

To identify the composition of a particular ceramic and how it was made, scientists at the Center first prepare a thin 30 μm section of the material. They then determine its geological makeup, comparing the individual grains to those of known rocks and minerals. While experienced scientists can scrutinize a given ceramic under a microscope and tell fairly quickly how the original pot was made, it may be difficult to pass the information along objectively to other scientists. Computer analysis, however, lets Whitbread objectively describe the microstructure. Specific variables he hopes to define include the alignment and size of particles and the proportion of certain components.

Whitbread is defining the microstructures of a range of amphoras from a particular area and time. Ultimately, he hopes to chart the boundaries of amphora variation so other researchers can determine whether their materials are within or outside these boundaries.

Other observations can lend clues to how the clay was prepared or the vessel was made. For example, Whitbread said, streaks in the materials could indicate the pot was made of a mixture of clays. In addition, orientation of individual particles can tell whether a pot was made by hand (such as coil-wrap pots) or thrown on a wheel. A coil-wrap pot is composed of a rolled cylinder of clay. As a result, the clay particles of the materials are aligned horizontally. In contrast, thrown pots "tend to have particles that are aligned at an angle, because the pot is being drawn up as it is being thrown," Whitbread said.

Merck Develops Deep Luster Coating with Interference Pigments

Researchers at Merck & Co., Darmstadt, Germany, have successfully created a pearly luster coating that largely reproduces the iridescence found in mother-of-pearl and butterfly wings.

Pearly luster, which appears as a silky, soft radiance seeming to emanate from deep within a material, can be produced artificially using extremely thin laminae made of transparent, highly refractive material. Immersed in an aqueous solution or placed under a coat of clear varnish, light rays impinging on the laminae are subjected to multiple reflections. Light is especially reflected by the upper and lower surfaces of the first lamina. The remaining light is transmitted to the next lamina, where this process is repeated.

Using titanium dioxide, which is lightfast and has an attractive luster, researchers introduced laminated substrates in mica form into a titanium salt solution. The titanium dioxide deposits itself on the mica to evolve into a thin, transparent layer.

This silicate layer must be sorted precisely according to its surface area. Laminas a few hundredths of a millimeter large produce a silky gloss; the larger the surface, the greater the degree of brilliance, so that ultimately, even glittering effects can be generated with laminas having a surface area of 0.1 mm.

To achieve a pearly luster, the layer of titanium dioxide must not be thicker than a few tens of nanometers. Greater thicknesses give rise to opalescence, a variable range of hues resulting from the superimposition of the light reflected by the lower surface of the layer on the light reflected by the upper surface. Depending on layer thickness, color wavelengths are enhanced or reduced.

Such "interference pigments" based on mica and titanium dioxide can be used for almost any purpose. In car body paints they offer deep luster and red hues not yet achieved by metallic paints. Environmentally less harmful than metallic paints, the pigments have been judged safe based on health, water insolubility, and relative safety on ingestion or skin contact, and so are also suitable for printed packaging material, garden fencing, bicycles, and cosmetics.

From *Special Science Reports, German Research Service,* **VIII,** No. 01/92, p. 7.

National Educators' Workshop Calls for Materials Experiments

The National Educators' Workshop (NEW), in its seventh year as an instruction workshop for educators who wish to upgrade their materials knowledge, is seeking experiments or demonstrations from scientists, engineers, educators, or technicians for use in materials laboratory courses. The submittals will be reproduced and distributed during the NEW:Update 92 workshop at Oak Ridge National Laboratory, November 11-13, 1992.

The long-range objective is to collect demonstrations and reproduce them in a *Manual of Experiments* available to educators through technical societies and the Materials Education Council.

Anyone interested in providing an experiment, must submit a brief abstract no later than **June 1, 1992** to: Dr. James A. Jacobs, NEW:Update 92, School of Technology, Norfolk State Univ., 2401 Corprew Ave., Norfolk, VA 23504; phone (804) 683-8109/8712). □