A Glass Mélange

New options for hazardous wastes?

By ADRIENNE C. BROOKS

In his one-room studio, surrounded by delicate glass figures and other creations, artist Rick Sherbert experiments with two dark chunks of glass.

After firing the furnace and melting the pieces together, Sherbert gathers the molten glob on the end of his long, narrow blowpipe. He blows a short burst of air down the pipe, turning the soft lump into a small, glowing bubble. Seated at his bench, he begins stretching and shaping the taffylike material, twirling and working the object until he forms a small vase.

Although sand, or silica, serves as the main ingredient of most glass, Sherbert's comes from a different, and unlikely, source — asbestos. A few days earlier, he had received the glass from researchers at Catholic University in Washington, D.C. Like alchemists of medieval times, these researchers had turned asbestos, a mineral fiber that can prove hazardous if inhaled or ingested, into safe, smooth glass.

From asbestos to a glass vase for the sweet, fresh flowers of spring? The image almost shatters the reality of the carcinogen as a health and environmental threat.

Asbestos ranks high on the list of hazardous materials. The Environmental Protection Agency estimates that it causes 3,000 to 12,000 cases of cancer, usually fatal, in the United States each year. And until now, dumping bags of the fire-retarding and insulating fibers in landfills was the primary way to dispose of it.

A growing number of people are now betting that the process of converting toxic materials into glass, called vitrification, can offer new options for disposing of asbestos and other hazardous wastes, even nuclear wastes. Whether they win that bet — and can take the technology out of the laboratory and into the marketplace — depends on a delicate balance of science and engineering, business acumen and public policy.

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Sherbert, at work in his studio, used glassblowing techniques similar to these to form a vase made of vitrified asbestos.

One entrepreneur who has staked his future on vitrification is Robert E. Prince, president of GTS Duratek, a small engineering company in Columbia, Md. He began by making an exclusive partnership arrangement with Catholic University's Vitreous State Laboratory (VSL), which developed and patented a process for converting hazardous waste into glass. With the technology in hand, Prince has focused his sights on what he calls the "multi-billion-dollar environmental cleanup market."

However, Prince wants to go one step further and recycle that glass into commercial products. He predicts eventual uses will include fill for building and highway construction projects, ceramic bricks, and even insulation.

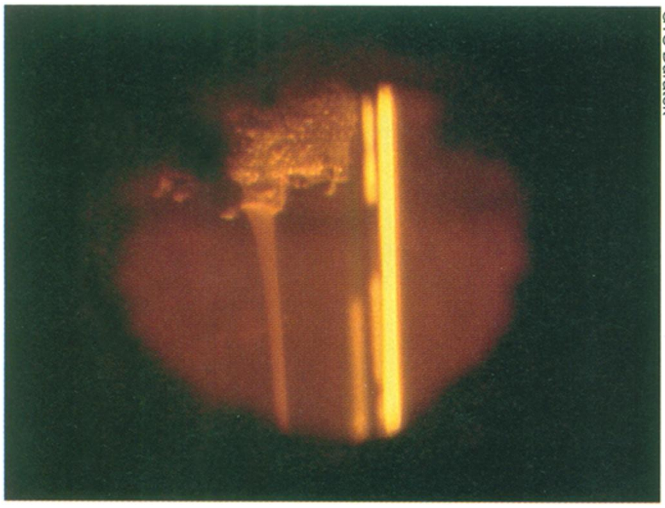
"Once it's been vitrified, asbestos is no longer hazardous," says Pedro Macedo, a Catholic University physicist and cochair of VSL. "Asbestos poses a threat to human health because it contains tiny fibers that can damage the skin and lungs."

The problem lies in the geometry of the fiber, Macedo explains. The crystal-like structure of the asbestos fibers breaks down above 900°C to form benign oxide compounds suitable for forming glass.

The EPA has no concerns about vitrifying asbestos. "Once the substance is vitrified, it becomes glass, and there are no known [environmental] issues surrounding glass," says Regina Lankton, an agency spokeswoman.

To create the glass, workers feed asbestos-filled polyethylene bags through a chute into a large furnace called a melter. The researchers automated the process as much as possible to eliminate any direct contact with the hazardous fibers. Reaching temperatures of more than 1,000° C, the melter heats the waste material along with a batch of borosilicate glass. The mixture bubbles and boils until it becomes molten glass.

Vitrification works on two levels. First, the furnace consumes the organic chemicals of the hazardous material and fuses the inorganic matter into glass molecules, reducing the volume of the original waste. Glass made from asbestos would take up only a fraction of the space in a landfill that bags of unprocessed asbestos would. Second, glass is extremely durable. "The waste is trapped in the glass, like the green color in a beer bottle," says Prince. "You can break the bottle, but the green



GTS Duratek

Molten glass emits a yellow glow as the asbestos bubbles in the melter.

stays in the glass."

According to Prince, vitrification can work with almost any form of waste — from soil contaminated by lead or radon, to medical wastes, industrial sludges, and radioactive wastes.

In fact, vitrification of hazardous wastes has its roots in the nuclear industry. The production of nuclear weapons for the Cold War created a costly and dangerous by-product: radioactive waste. The Department of Energy has estimated it would take 30 years and $100 billion to clean up that waste — assuming it's possible to do so at all.

Macedo began fusing nuclear waste into glass in 1985, when DOE sought VSL's help in processing high-level uranium and plutonium wastes at its West Valley, N.Y., nuclear weapons facility. "We worked on the composition for the glass, what additives were needed, how to prove its durability, and how to control for any potentially hazardous gases produced in the process," he recalls.

In the end, Macedo and VSL figured out how to manage the technology, but it had one catch — the cost. "It costs about $800 a pound to process high-level nuclear waste, which, given its radioactivity, was acceptable."

GTS Duratek's first major project involved the nuclear weapons plant at Fernald, Ohio, last August. Taking soil contaminated by uranium and mixing it with sludges from industrial plants, the company's engineers found they could get two cleanups for the price of one. Bidding against other companies that proposed to dispose of the waste in the traditional manner, by mixing it with cement, GTS Duratek won the contract.

"Duratek had the lowest bid because they didn't need to mix in expensive additives," says Gerald G. Boyd, DOE's associate deputy assistant secretary for technology development. "Rather, their engineers analyzed all the wastes on the site and figured out which ones could be blended together, based on their chemical composition, to make durable glass."

Boyd also thinks the technology behind the vitrification process holds up better than current disposal techniques. "Glass binds the material instead of just mixing it up together, as with cement," he says. "It's very stable, so you don't have to worry about the waste getting into the groundwater anytime soon — although it's still hot, so you don't want people to get too close."

GTS Duratek is under contract with DOE to build a melter at the agency's Savannah River nuclear weapons plant, in Aiken, S.C., to turn that site's waste into glass.

Taking vitrification a step further, people concerned about nuclear weapons are looking at it as a way to eliminate the highly enriched uranium and plutonium contained in dismantled nuclear warheads.

Through various disarmament agreements, the United States and Russia are committed to getting rid of thousands of nuclear weapons. Yet disposing of these warheads remains a problem. The possible resale of the weapons-grade material on the nuclear black market and its use by terrorists poses an additional concern.

The National Academy of Sciences' Committee on International Security and Arms Control has identified vitrification as a possible technology for solving this problem. In its March 1994 report "Management and Disposition of Excess Weapons Plutonium," the committee recommends two options: Reuse plutonium as fuel in existing or modified nuclear reactors, or vitrify the material, making reuse extremely difficult.

To Arjun Makhijani, president of the Institute for Energy and Environmental Research (IEER) in Takoma Park, Md., vitrification comes out the clear winner. Last November, IEER issued a report, "Fissile Materials in a Glass, Darkly," that calls vitrification "the first practical plan for putting all excess U.S. plutonium into nonweapons-useable form."

Such global issues aside, vitrification may prove a disarmingly effective technology for resolving more routine waste problems that jeopardize human health and the environment. As Rick Sherbert sits at his workbench, engaged in the ancient art of glassblowing, he reflects on the possibilities of the tiny vase created from vitrified chunks of asbestos. That he could transform that material into an object of art doesn't really surprise Sherbert. "Why not?" he asks. "It's glass." □

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Sherbert created the small black vase (left) entirely from chunks of vitrified asbestos. The speckled vase, formed from a mix of vitrified asbestos and commercial glass, is the work of Jerry Hovanec, an artist with the National Museum of American Art in Washington, D.C.