Levitation yields purer glass

A new glass developed with the help of a unique NASA levitator facility is now available for commercial applications such as lasers and optical communications.

"We have patented a family of new glasses and have established processes for making and using them in practical applications," says Richard (Rick) Weber, director of the Glass Products Div. of Containerless Research (CRI), the small Evanston, Illinois, company that invented and now produces the new material, called REAl Glass. "We are already making commercial quantities of glass rods and plates for use in lasers," he says.

Unique benefits, new process

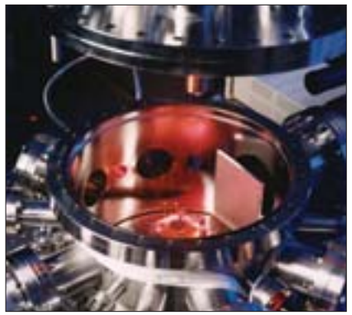
Made from rare earth oxides, aluminum oxide, and small amounts of silicon dioxide, REA1 Glass has unique properties that were identified using the company's containerless processing techniques as well as a NASA ground-based research facility. This family of glasses will bring higher power to smaller packages in lasers and optical devices. It will also provide a less expensive alternative to many other optical glasses and crystals such as sapphire. REAl Glass materials are durable, provide a good host for atoms that improve laser performance, and may extend the range of wavelengths that a single laser can currently produce.

A few years ago, as part of a NASA research grant for a proposed International Space Station flight experiment, Weber conducted research in the Electrostatic Levitator at NASA Marshall in Huntsville, Alabama. The levitator, wherein molten spheres of glowing material float with no visible means of support or containment, is one of the nation's few facilities where scientists can process materials without using containers, which introduce contamination.

With the NASA device, researchers levitated the materials using static electricity and then heated them to extremely high temperatures. In this process, the materials were completely protected against contact with a surrounding container or any other source of impurities. Weber says the containerless process lets CRI produce glass samples that do not have even trace quantities of silica.

With additional support from the National Science Foundation (NSF), CRI recently developed the REAl Glass manufacturing process. NSF is now supporting the company's development of glasses for use in power lasers, surgical lasers, optical communications devices, infrared materials, and sensors that may detect explosives and toxins.

"NSF funded the technology at a stage when there were very few companies or venture capitalists that would have made the choice to invest," says Winslow Sargeant, the NSF officer who oversees CRI's Small Business Innovation Research award. "We supported the REAl Glass research because we saw there was innovation there," adds Sargeant. "They are a great company with a good technology, so we provided seed money to establish the technology's feasibility. Right now, we can say the feasibility is clear, and they are one step closer to full-scale manufacturability," he says.



The Electrostatic Levitator facility at NASA Marshall supports the agency's Microgravity Materials Science Research Program.

"The development of REAl Glass shows how the SBIR program works by building on good ideas that come from basic research and helping small businesses grow into commercial manufacturers of innovative products," says Sargeant. "We are working with Containerless Research by supporting product research and development that can help them grow the business and continue to create new products and new jobs," Sargeant explains.

Resisting the flow

"The research that led to the development of REAl Glass concerned the nature and properties of 'fragile' liquids, substances that are very sensitive to temperature and have a viscosity [resistance to flow] that can change rapidly when the temperature drops," says Weber.

REAl Glass, like many other glasses, is made from a supercooled liquid. This means that the liquid cooled quickly enough to prevent its atoms from organizing and forming a crystal structure. At lower temperatures, such as room temperature, the atoms are "fixed" in this jumbled, glassy state. With REAl Glass, the glass-making process also provides a mechanism for incorporating rare-earth elements in a uniform way. This quality makes REAl Glass particularly attractive for laser applications.

CRI scientists spent several years on fundamental research into fragile liquids. NSF then provided funds to develop both patented glasses and proprietary manufacturing processes for combining the glass components in commercial quantities and at a cost much lower than that of levitation melting. Using high-temperature melting and forming operations, CRI is making REAl Glass in 10-mm-thick rods and plates, establishing a basis for inexpensive, large-scale production of sheet and rod products.

CRI researchers made these samples of glass without the use of containers as part of the development of REAl Glass materials.

"The REAl Glass products are a new family of optical materials," says Weber. He adds that CRI is already meeting with businesses to talk about requirements for laser, infrared window, and other optical applications, and supplying finished products or licensing the material for use.

"The REAl Glass technology combines properties of competing materials into one [material]," says NSF's Sargeant. "With these glasses," he continues, "researchers can design smaller laser devices, because of the high power density that can be achieved, and can provide small, high-bandwidth devices for applications in the emerging fiber-to-the-home telecom market."

REAl Glass provides a medium for next-generation optical communications devices that need to be small, low-cost, and powerful to provide fiber for broadband Internet. The glass composition can be customized for these uses.

Because the glass can incorporate a variety of rare-earth elements into its structure, CRI can craft the glasses to yield specific properties, such as the capability to tune a laser across multiple light wavelengths. The ability to tune the light wavelength can have important implications for the lasers used in dental procedures and surgery, providing more control for operations involving skin shaping or cauterization.

A CRI worker casts bulk REAl Glass ingots.

Heart of the laser

Lasers are among the most promising applications for the new glass. Whether it is a power laser for cutting metal for car bodies or a medical laser used for surgery, the "heart" of lasers is the gain medium, which is where REAl Glass can be used. This critical component increases or amplifies light, resulting in an intense, highly concentrated beam capable of precisely cutting metal parts and surgically removing or repairing human tissue.

"Most surgical lasers now use expensive single crystals, which limit the range of operating wavelength to very narrow bands," explains Weber. "REAl Glass would provide tunability, which can give more control over surgical procedures, an important factor in different types of surgery and for different skin types. Our glass can provide efficient power lasers and expand coverage to new wavelengths," he says.

Other possibilities

Additional funding comes from the Air Force Office of Scientific Research, which is supporting CRI's research into applications, including materials for infrared waveguides and sensors needed to identify chemical components. CRI is also continuing basic research on fragile oxide liquids, which they believe still offer much potential for generating new materials and, ultimately, optical devices.

"This shows how basic NASA research can lead to innovative materials and new products that can benefit everybody," says Michael Wargo, enterprise scientist for materials science in NASA's Office of Biological and Physical Research in Washington.

REAl Glass has qualities useful in creating materials for demanding optical applications. "We have taken many of the best qualities of the current materials and created a new glass that can be produced inexpensively," Weber says.

The family of REAl Glass materials is patented under U.S. Patent No. 6,482,758 issued Nov. 19, 2002, and is available only from Containerless Research, or under license.

For information on NASA's Electrostatic Levitator, visit: http://www.msfc.nasa.gov/news. For information about REAI Glass and Containerless Research, visit: http://www.containerless.com/realglass.htm.

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