DATA FOR THE 31st CENTURY

New tech lets us store data for centuries, but who wants that?

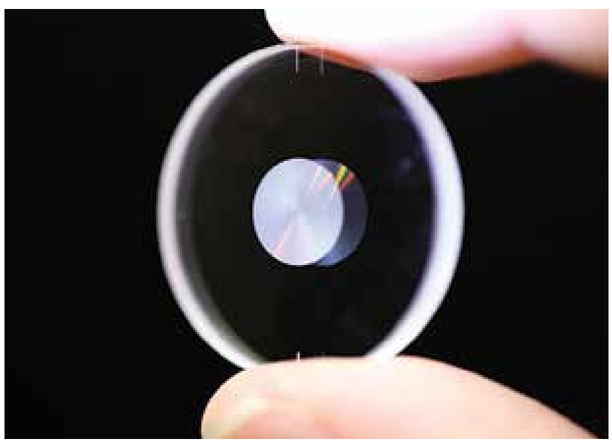
Computer scientist Peter Kazansky at the University of Southampton, in England, has some words for the ages. He and a group of collaborators wrote them in quartz crystal using new optical techniques that could preserve the text for millennia. The message, which consisted of the abstract of the paper announcing the work, is stored as two types of alterations in the way quartz glass refracts light. The combination of the two allows for data-storage densities as high as 360 terabytes per disc, or more than 7000 times today's 50-gigabyte double-layer Blu-ray capacity.

There's always a catch, though. Reading the message requires an electron microscope, and the process may never provide faster access to stored data than existing technology can. This and similar over-the-horizon memory research may someday improve big-data storage, but such systems aren't an easy fit with today's data-storage needs, experts say. Improved density and durability are both helpful, but readability and the capacity to rewrite data in a different format might be more important.

Long-term data storage is one part of what Mark Watson, Oracle's director of hardware development, calls the data-storage pyramid. At the tip of that pyramid are data that users want immediate access to, such as new photos posted to social networks. For that, server farms use the latest fast-writing and -reading media, such as solid-state flash memory or spinning magnetic hard disks. Some companies are even shifting such data to their server's fastest-access memory, volatile dynamic RAM. Oracle is taking that tack to the extreme with a new database system housing a whopping 32 TB of DRAM.

But users may also need to park some data long term for legal reasons, or for future big-data analysis, without the need for frequent or fast access. For that, archivists can use storage media that are slower but much cheaper on a per-bit basis. Kazansky and his colleagues' optical innovations may fit into that layer of the data-storage pyramid.

To justify its place, a quartz media format would need to be more cost-effective than the base of today's data-storage pyramid, which is old-fashioned magnetic tape. "For archive, tape is still quite an important medium," says physicist Thomas Thomson of the University of Manchester, in England. That attitude is common among storage experts, who note that even as optical discs approach 300 GB, magnetic-tape costs continue to drop as densities, reliability, and speeds climb. One estimate puts them at 4 U.S. cents per gigabyte.



DISC OF DESTINY: Using alterations in the way quartz refracts light, we could store data in a superdense form for centuries.

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One problem quartz does solve is the degradation of data in present-day media. "You're going to lose information," warns information technology consultant Michael Peterson, so archive systems must strike a balance between durability and cost. As storage media age, most archive managers copy the data to new media. Kazansky's team predicts that their data could remain legible for centuries, and the longer they can delay migrating the data, the lower the cost of archiving. "We can give all our knowledge to future civilizations," says Kazansky.

Quartz isn't the only millennial medium in the works. In 2009, researchers stored information using iron nanoparticles inside carbon nanotubes, a configuration they say could last a billion years. In 2012, Harvard University researchers encoded an entire 53 000-word book into a 50-nanogram clump of DNA.

But David Rosenthal, a digital preservation expert at Stanford University, warns that the market for such durable data is small. Instead, he argues, most archives already move their data to new media long before the original media's expiration date, to take advantage of incremental technological improvements that save space and energy. The plan to develop a 300-GB Blu-ray disc is a good example of the sort of incremental advances that help reduce archiving costs without really changing how archiving is done, Peterson says.

In fact, the way we store data, such as using standards for metadata that ensure the data's accuracy, is evolving just as fast as the hardware on which the data is preserved, says Rosenthal. "What we learn in the digital-preservation world is that it's not about the storage media; it's about the system," Peterson says.

There is one notable exception to this constant copying and upgrading: In deep space, nobody can update your archiving system. Voyager 1 recently reached interstellar space, carrying a gold-plated record and the needle to play it with, which are intended to survive the multimillennial journey to other star systems. If Voyager or any of our other starbound spacecraft inspire aliens to visit, will they find a society with thousands of years of updated digital archives? Or will it just be a few ragged bits in a long-abandoned format that read, "Look on my data, ye mighty, and despair!" —LUCAS LAURSEN