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Easier medium gives maximum capacity

US-based Aprilis is planning to launch a holographic data storage system that it hopes will be one of the first to market. Vice-presidents of business development and research, Glenn Horner and David Waldman, spoke to optics.org about the technology.

Last year Michael Ruettger, the executive chairman of the data storage giant EMC, predicted that by 2003 the typical global business will serve more than a petabyte (1024 terabytes) of online data. Industry reports suggest that this was probably an underestimate and as today's market accelerates, there is a pressing need for new, higher-density methods of data storage to keep up with demand.


Glenn Horner

One company intending to capitalize on this fact is Aprilis, a US developer of holographic data storage systems. Aprilis started out as the holographic storage research arm of US imaging giant Polaroid. Established as a separate company in 1999, the spin-off is focusing on developing holographic data storage for large-scale enterprise applications. The company claims to have produced a five-inch disk that holds more than 100 Gbytes of data, and independent trials have revealed massive recording rates of 100 Mbytes per second.

"Magnetic, and even optical storage systems are too slow and do not have enough capacity to meet the exploding data storage demands," says Aprilis's vice-president of business development Glenn Horner. "[However], holographic technology has extremely high capacities, fast data access and exceptional data transfer rates."

Three dimensions are better than two

Proponents of holographic data storage argue that the technology is better than existing storage methods because it stores digital information in three dimensions, rather than two. Magnetic and optical methods hold bits of data as variations on the surface of the recording medium, but holographic storage holds an entire page of information as an optical interference pattern within a photosensitive material.

A laser is split into two beams, the first serves as a reference while the second is encoded with digital information. Both beams are intersected within the photosensitive storage material to produce an interference pattern. The pattern triggers chemical and physical reactions in the medium, forcing it to store a replica of the interference fringes as a change in either its absorption, refractive index or thickness. The data can later be retrieved by exposure to light from one of the beams.

This process may sound relatively simple, but scientists eager to

commercialize the technology have been dogged by complications. The first holographic data storage systems were based on lithium niobate crystals. However, these materials are difficult to manufacture, exhibit poor recording sensitivity and the light that is used to write the holograms also erases them during reading.

More recent developments in holographic data storage have focused on photopolymerizable materials. While these display good recording sensitivities they are prone to data-damaging shrinkage problems. However, Aprilis believes it has created a holographic recording technology that solves these problems.

"We have developed a medium based on our patented polymerization technology, that has low shrinkage and high recording sensitivities, " said David Waldman, vice-president of research and development at Aprilis.

Building blocks bring winning solutions

The company's technology is based on a cationic ring-opening polymerization (CROP) process, which uses a low-shrinkage oxirane monomer to build the polymer medium rather than the more common vinyl monomer. Aprilis claims to have reduced shrinkage during polymerization, and cut down on unwanted side-effects such as impaired image fidelity and storage capacity.


Disk system

Aprilis first demonstrated that it could practically harness the potential of holographic data storage in November 2000. A review of systems that had been developed under PRISM, a program to develop photorefractive information storage materials funded by the National Storage Industry Consortium (NSIC) and the Defense Advanced Research project Agency (DARPA), was held at Stanford University. Here Aprilis's technology, with its 10 Gbit per second data transfer rates, outstripped technologies from rivals such as IBM, Eastman Kodak and Rochester Photonics.

Having since received millions of US dollars in venture capital, the company claims to be the first to develop a commercial holographic data storage system. Intent on delivering a commercial product by the summer of 2003, Aprilis will have to keep an eye on data storage developers with similar plans.

One such company is Germany-based Optostor. Instead of exploiting the storage properties of a photopolymer, the Cologne University spin-off has focused on developing the properties of lithium niobate crystals. Researchers from a new Canadian photonics company, Optemia, alongside the Spanish Complutense University of Madrid, have also created an alternative system based on a photopolymerizable glass.

Although these systems combat shrinkage problems, Waldman is confident that Aprilis's system is more sensitive, simpler and cheaper. "[During reading, systems based on lithium niobate crystal] partially erase previously recorded holograms," he said. "This means that the technology requires heating during recording, to secure information." He also believes that glass-based systems require expensive lasers that are less energy-efficient than those used by Aprilis.

Starting out at difficult times

If Aprilis's holographic storage system lives up to Waldman's claims, the company could be on its way to helping its more established peers meet the huge data demands of tomorrow. And as EMC outlines its plans for the next generation of information storage amid an economic downturn, the signs are encouraging that data storage start-ups such as Aprilis will be able to weather this, and future, financial storms.

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